Aviation Week

and Space Technology

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July 24, 1961

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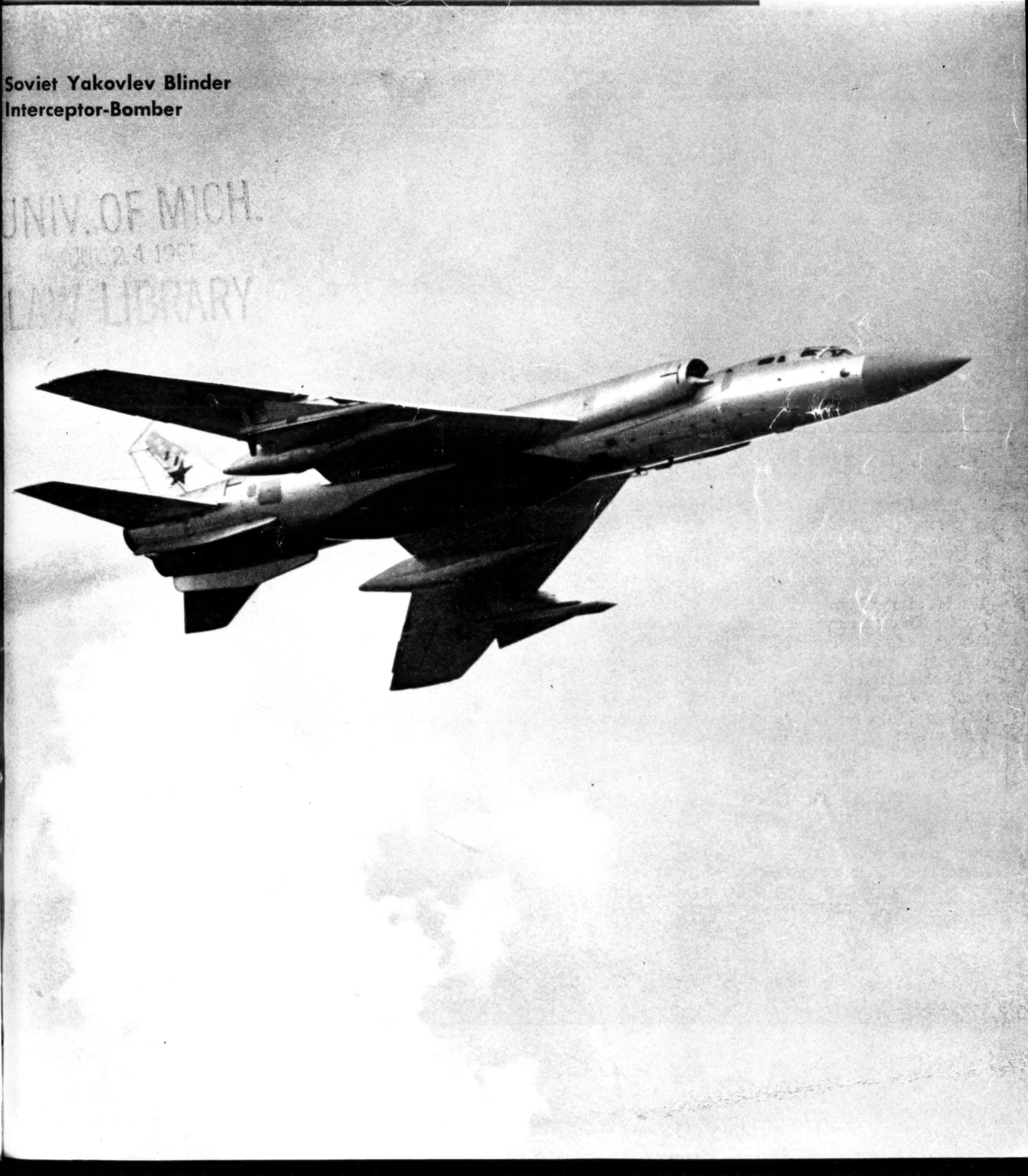

Soviet Yakovlev Blinder Interceptor-Bomber

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AVIATION CALENDAR

Aug. 1-3—Fourth Western Regional Meeting, American Astronautical Society, Sheraton-Palace Hotel, San Francisco, Calif.
Aug. 1-10—28th Annual U. S. National Soaring Championships, Wichita, Kan.
Aug. 2-4—Summer Meeting on Aerospace Applications for Hydraulic Fluids Test Methods, American Society for Testing Materials, Santa Ynez Inn, Pacific Palisades, Calif.
Aug. 3-6—North Central States' Airport Managers Conference, Mason City, Iowa.
Aug. 7-9—Guidance and Navigation Conference, American Rocket Society, Stanford University, Palo Alto, Calif.
Aug. 15-17—Cryogenic Engineering Conference, University of Michigan, Ann Arbor.
Aug. 16-18—International Hypersonics Conference, American Rocket Society, MIT, Cambridge, Mass.
Aug. 19-24—Institute of the Aerospace Sciences/Naval Aviation Meeting, San Diego, Calif. (classified).
Aug. 22-25—Western Electronic Show and Convention, Cow Palace, San Francisco.
Aug. 23-25—Fourth Biennial Gas Dynamics Symposium, American Rocket Society, Northwestern Technological Institute, Evanston, Ill.
Aug. 24-26—Sixth Annual National Reunion, OX5 Club of America, Allis Hotel, Wichita, Kan.
Aug. 28-30—West Coast Conference of Applied Mechanics, University of Washington, Seattle, Wash.
Aug. 28-Sept. 1—International Heat Transfer Conference, University of Colorado,

(*Continued on page 6*)

AVIATION WEEK and Space Technology

July 24, 1961
Vol. 75, No. 4

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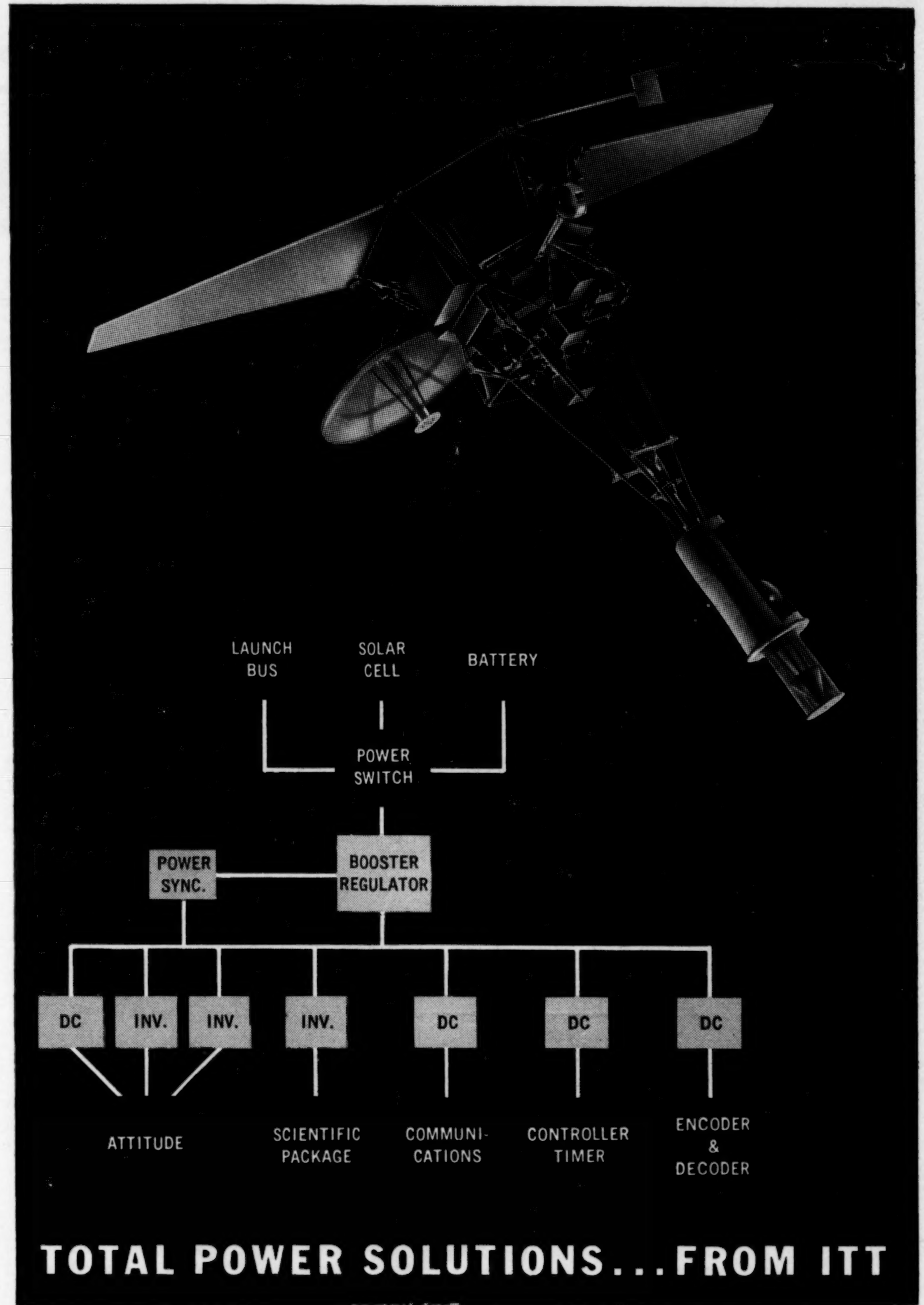

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(*Continued from page 5*)

Boulder, Colo.

Aug. 30-Sept. 1—Second Annual Bionics Symposium, General Electric Advanced Electronics Center, Cornell University, Ithaca, N. Y.

Aug. 30-Sept. 1—Third Annual Semiconductor Conference, American Institute of Mining, Metallurgical and Petroleum Engineers, Ambassador Hotel, Los Angeles.

Sept. 4-10—1961 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Sept. 4-14—Eighth Anglo-American Aeronautical Conference, Royal Aeronautical Society and Institute of the Aerospace Sciences, London, England. Wilbur Wright Memorial Lecture, Sept. 12.

Sept. 6-8—National Symposium on Space Electronics and Telemetry, Institute of Radio Engineers, University of New Mexico, Albuquerque, N. M.

Sept. 7-8—Fall Meeting, Western States Section/The Combustion Institute, University of California, Berkeley, Calif.

Sept. 10-12—National Convention, National Aeronautic Assn., Westbury, N. Y.

Sept. 13-14—International Operations and Maintenance Symposium, Airwork Corp., Millville, N. J.

Sept. 13-15—16th Annual Meeting, Armed Forces Chemical Assn., Statler-Hilton Hotel, Washington, D. C.

Sept. 14-15—Ninth Annual Joint Societies Engineering-Management Conference, Institute of Radio Engineers, Hotel Roosevelt, New York, N. Y.

Sept. 15-17—Annual Convention, National Assn. of State Aviation Officials, Miami Beach, Fla.

Sept. 20-21—Industrial Electronics Symposium, Institute of Radio Engineers, Bradford Hotel, Boston, Mass.

Sept. 20-24—National Convention and Aerospace Panorama, Air Force Assn., Philadelphia, Pa.

Sept. 26-28—Annual Convention, National Business Aircraft Assn., Mayo Hotel, Tulsa, Okla.

Sept. 29-30—Society of Experimental Test Pilots' Fifth Annual Symposium (including a forum on the Supersonic Transport) and Awards Banquet, Beverly-Hilton Hotel, Beverly Hills, Calif.

Oct. 2-4—Seventh National Communications Symposium, Institute of Radio Engineers, Hotel Utica, Utica, N. Y.

Oct. 2-7—12th International Astronautical Congress, Washington, D. C.

Oct. 3-5—National Airports Conference, University of Oklahoma, Norman, Okla.

Oct. 9-13—National Aerospace Engineering & Manufacturing Meeting, Society of Automotive Engineers, Ambassador Hotel, Los Angeles, Calif.

Oct. 9-15—American Rocket Society's 16th Annual Meeting & Space Flight Report to the Nation, Coliseum, New York, N. Y.

Oct. 14-22—Federation Aeronautique Internationale 1961 General Conference, Hotel Quintandinha, Rio de Janeiro, Brazil.

Oct. 23-24—Joint Meeting, Canadian Aeronautical Institute/Institute of the Aerospace Sciences, Ottawa, Canada.

Oct. 23-27—17th Annual General Meeting, International Air Transport Assn., Sydney, Australia.

July 24, 1961

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and **Space Technology**

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COVER: Soviet Blinder, long-range Mach 2 interceptor, is the latest effort of the design team headed by Alexander Yakovlev and shows influence of earlier medium bomber Backfin (AW July 17, p. 31) designed by the same group. Blinder has been flying since 1959 and Western observers first thought it a bomber, but details of its air-to-air missile armament and large airborne intercept radar indicate its function as a long-range interceptor. Twin-jet engines are shoulder-mounted with double tailpipe visible above ventral fins. Large black bulge under the fuselage is either long-range search radar for reconnaissance purposes or an external fuel tank for additional range.

PICTURE CREDITS
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EDITORIAL

Another Surprise Coming?

The Tushino air show of a few weeks ago provided a sharp surprise to the American people, who had been misled by their leaders in recent years to believe that the Soviet Union had abandoned advanced development of manned aircraft and was concentrating solely on ballistic missiles and space weapons. These leaders in turn have been badly informed by their intelligence services, not because of the working-level input but because of top-level intelligence counsel decisions to ignore evidence that did not suit their preconceived ideas of what should be transpiring.

Although Cuba and Tushino revealed some of the incredible incompetency in the use of our national intelligence estimating machinery, the full impact of this sad bureaucratic bungling has yet to be told, primarily because it is well shielded under the official stamp of secrecy.

However much of a shock it is to the American people to discover that the Red Air Force, which was supposed to be fading into obsolescence, had suddenly blossomed out with a full array of new generation aircraft across the whole technical spectrum from supersonic bombers and long-range interceptors to assault transports and helicopters, we wonder if an even greater shock may not be in the offing. We wonder if the self-imposed ban on nuclear testing that the United States has been operating under for the past three years may not be leading toward the dissipation of our once commanding lead in nuclear weapons development. Will we wake up another Monday morning soon and find that the Soviets have been secretly testing new generations of nuclear weapons when they confront us publicly with their operational capability?

This possibility has also been raised by John McCone, a California Republican who has had a long and distinguished career in government, both in the Defense Department and as chairman of the Atomic Energy Commission. This is what he had to say on this point recently:

"Nuclear weapons development by underground and outer space testing will give to either the United States or the Soviets an arsenal of weapons, both large and small, more powerful, more versatile and more useful in modern warfare than those now existent. The Soviets can proceed with these developments behind their walls of secrecy without detection, as no present scientific means of discovering their actions exist or can be created without inspection posts within their country and the right for on-site inspection.

"The Soviets' adamant refusal to accept a reasonable plan for policing a test ban agreement by refusing appropriate means for inspection is reason to believe they are developing new and improved weapons by clandestine testing. Thus they can develop a great military superiority, and we, respecting a self-imposed moratorium, will take second place.

"Efforts to reach agreement have now failed because of Soviet unreasonable positions. Our security is at stake. We must resume weapon testing as essential to the safety of our country and the free world. Soviet protestations that they are not interested in testing appear undependable as similar statements were frequently made regarding manned aircraft, but now they display several new military planes secretly developed.

"Will they soon display advanced nuclear weapons?"

The initial impetus toward a nuclear test ban came from the world-wide public hysteria over nuclear fall-out assiduously promoted by the Soviet Union. Admittedly, the stupid secrecy imposed by the Atomic Energy Commission on the basic facts of fall-out contributed enormously to the success of the Soviet hysteria promotion and is another key example of how secrecy hurts much more than it can possibly help.

Now, however, the techniques of underground testing have been developed to the point where considerable development work can be done by this method without any atmospheric fall-out. Development of nuclear testing in outer space is certainly feasible, although considerable work on adequate instrumentation must be done before it will be practical. Here too, atmospheric fall-out is eliminated.

The really important lesson to be learned from the Tushino air show of 1961 and the fatal trap to be avoided in continuing a unilateral nuclear test ban is that in dealing with the Soviets, we must cover all technical possibilities across the board if we are to avoid the disastrous consequences of strategic surprise. There is no easy shortcut to national security in dealing with as determined and formidable an adversary as the USSR. The Soviet Union is developing every phase of its military power, from the masses of land troops re-equipped with mobile missiles that move by giant helicopter or armored caterpillar launching vehicles, airborne tanks and artillery to the supersonic bombers and fighters of the air force, also armed with formidable missiles, to the ballistic missile rocket forces and finally into the military applications of outer space.

This country can no longer afford to swallow the complete untruth that our military forces are in readiness to cope with any situation the Soviets may present. In all but a few areas our state of military preparedness is extremely low.

If we are to convince either our friends or foes that we mean what we say about Berlin or any of the other crises that are certain to arise along the U.S.-USSR interface, we had better stop talking about how wonderful our "wonder weapons" are and begin to actually do something about plugging the great gaps that exist in our current military power. At the same time, we must continue adequate preparations for the future development of all of the incredibly fantastic possibilities the galloping technologies of our time now reduce to the realm of probability.

—Robert Hotz

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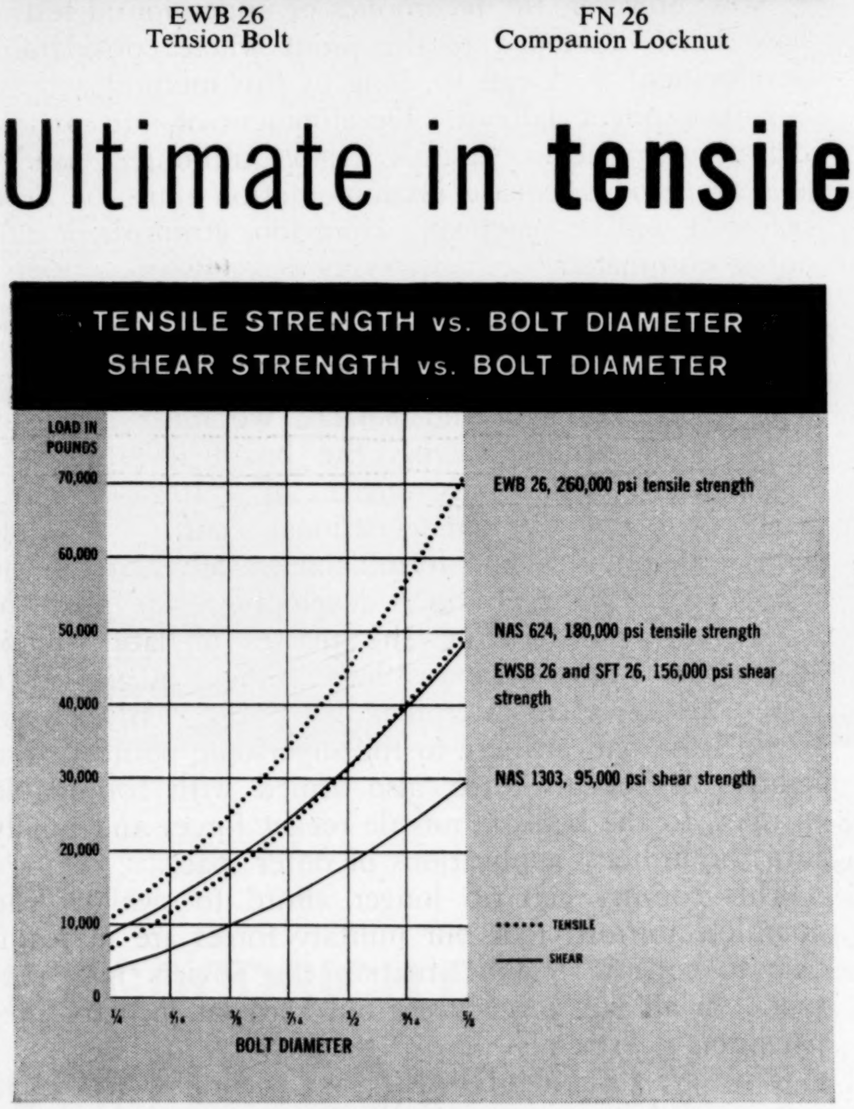

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Honors and Elections

The **Hon. H. G. Nelson** has been elected president of the Society of British Aircraft Constructors for 1961-62 succeeding **Sir George Dowty**, who becomes deputy president. **Sir Roy Dobson** was elected vice president.

John H. Halliburton has been named president of the Airlines Operations Conference of the Air Transport Assn., and **Carl A. Benscoter** has been named vice president. Mr. Halliburton is vice president-operations of Eastern Air Lines; Mr. Benscoter is vice president-operations of Mohawk Airlines. Named to the Advisory Committee of the Conference: **Kenneth B. Haugen**, director-flight operations of Northwest Airlines; **Floyd D. Hall**, vice president and general transportation manager of Trans World Airlines.

INDUSTRY OBSERVER

► Douglas Model 2229 supersonic transport proposal is designed with wingtips that fold downward in Mach 3 cruise at about 70,000 ft. to improve directional stability. Wingtips would be horizontal for good low-speed handling. Variable geometry design and large wing area for high altitudes should enable the aircraft to use all airports now served by subsonic jets, and seat mile costs are to be comparable with current jet costs.

► French Ministry of Transport has requested a meeting with the British Ministry of Aviation as soon as possible to spur joint development of a supersonic transport. Representatives of Sud Aviation and British Aircraft Corp. probably will participate.

► Tactical Air Command has asked Lockheed Aircraft Corp. for bids on fitting 75 F-104 aircraft with pods for folding fin rockets, which presumably could be used in both air-to-air and air-to-ground operations.

► Preliminary studies by General Dynamics/Ft. Worth indicate the B-58 bomber could carry a combination of two Douglas Skybolt air-launched ballistic missiles, which would greatly increase its standoff bombing capability, and two one-megaton yield tactical free-fall bombs. Heat considerations would limit flight to subsonic speed. B-58 air-launched several ballistic vehicles in feasibility tests that led to the Skybolt program.

► United Technology Corp. is scheduled to ground test in about two weeks a single-segment, flight-type solid rocket engine designed to deliver 250,000 lb. thrust for approximately 1 min., although duration may be substantially longer. Developed under National Aeronautics and Space Administration contract, the engine has a mass ratio approaching 0.90 and a very large propellant web. Storage life may be as long as two years.

► Rollout of the first North American B-70 is scheduled for September, 1962. Plans for streamlining management of the program will be presented this week in Los Angeles at the second meeting of the B-70 executive council, which consists of top Air Force officials and major contractor executives.

► New version of the Short Seacat anti-aircraft missile, capable of tracking a target in zero visibility, is under development by Short Brothers & Harland. The Seacat now in production is aimed visually.

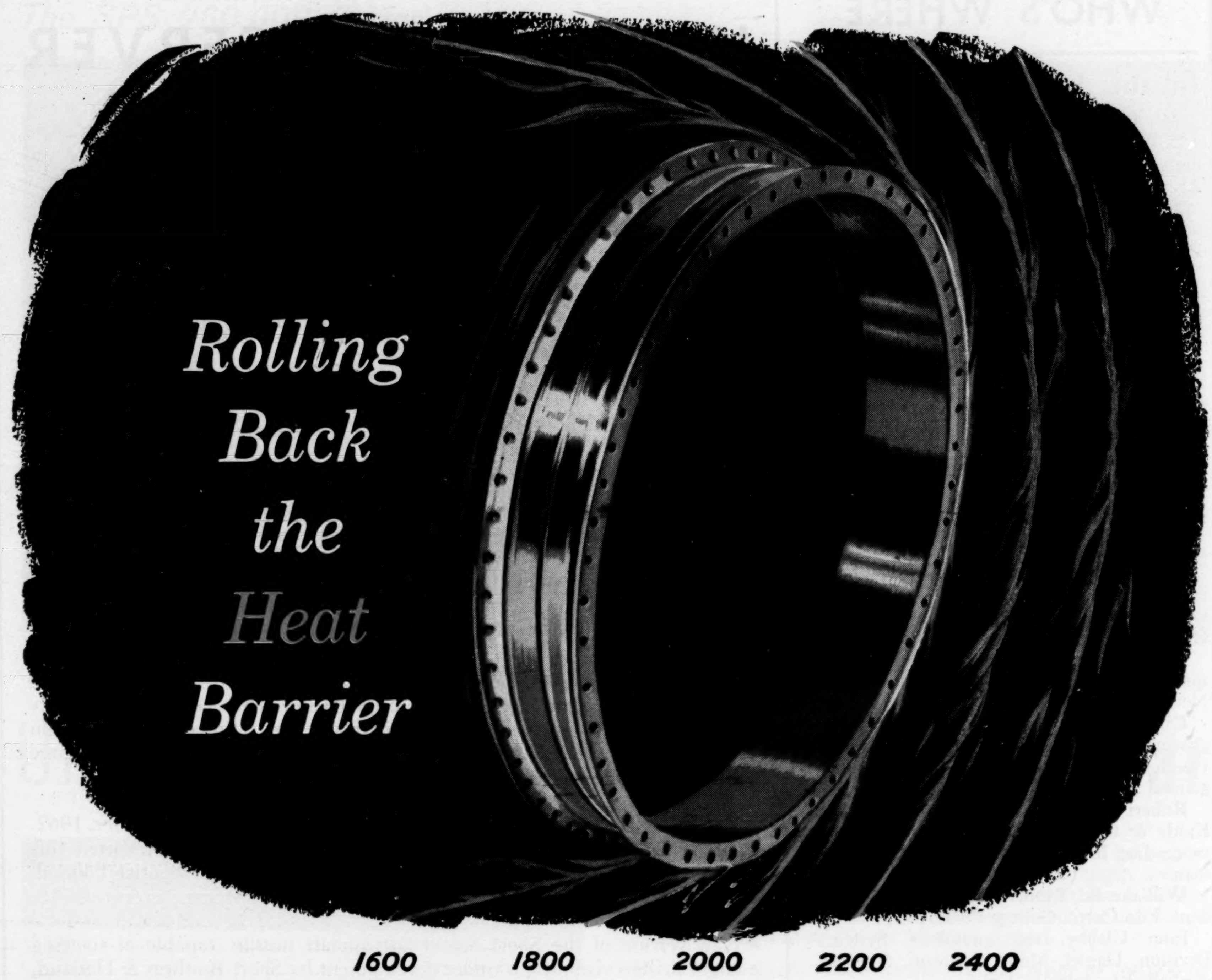
► Machine capable of reading Russian text in a variety of type faces and converting it into binary computer code at the rate of seven pages per minute will be unveiled soon by Baird Atomic Co. The machine was developed under Rome Air Development Center sponsorship.

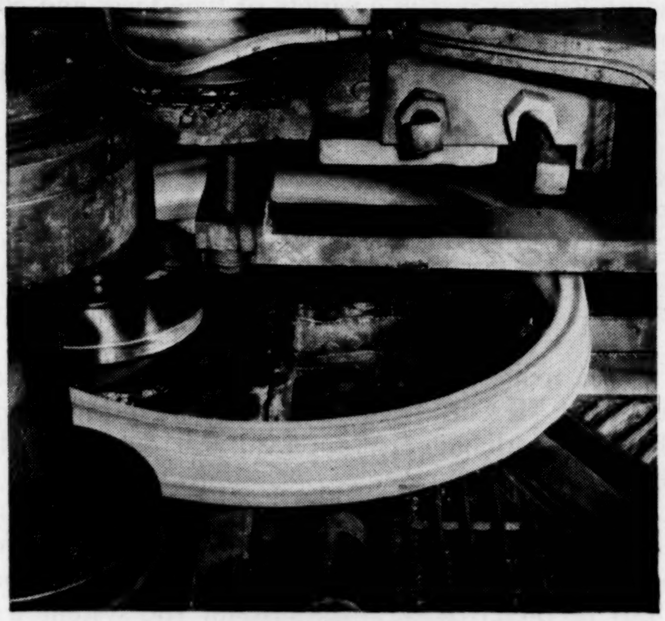
► First Atlas Centaur space launch vehicle has been undergoing cold flow fueling tests at Cape Canaveral. Main purpose is to check the liquid hydrogen-liquid oxygen fueling system at Complex 36. Centaur stage which has been used for mating and ground equipment checkout tests is scheduled for second flight test. Another Centaur stage will be used on the first flight.

► British government has agreed to allow the National Aeronautics and Space Administration to build a Project Mercury tracking station on Canton Island in the South Pacific, subject to parliamentary approval. All data is to be made available to the British.

► NASA's Goddard Space Flight Center will request proposals July 28 for a data acquisition and analysis system to be used in conjunction with Goddard's space simulator. Draft of preferred specifications for the system was prepared recently by Booz Allen & Hamilton.

► Air Force plan to put millions of tiny metal threads in orbit to serve as a passive communications satellite has been shelved at least temporarily by USAF Under Secretary Joseph Charyk. This action stemmed from concern that such a cloud of dipoles might obscure vision of the Samos reconnaissance satellite, and objections also have been raised by optical and radio astronomers. This program, Project Westford, originally was called Project Needles.





Manufacturer uses ring-roller to shape turbine seal rings made of HASTELLOY alloy X

The surging power of modern 20,000-pound thrust jet engines is being harnessed effectively by critical parts made of HAYNES high-temperature alloys. Turbine seal areas are typical of the hot spots in which these alloys serve. Here, in the form of turbine seal rings, they contain the hot combustion gases as they roar through the various turbine stages.

In these, and in other parts too, such as afterburner liners, flame holders, shrouds, and investment-cast turbine blades and nozzle vanes, HAYNES alloys are resisting the punishing effects of long hours at high temperature. In fact, one of the Air Force's latest 1500-MPH jets uses six different HAYNES alloys in vital parts where heat and stress would weaken and fatigue other materials.

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Washington Roundup

Soviet Fighter Exports

Soviet Russia now is exporting its latest generation of operational supersonic fighters to Soviet satellite air forces and is pushing first-generation supersonic fighters and jet bombers into countries with communist leanings.

East Germany, Hungary and Poland now have the Mikoyan Mach 2, delta-wing Fishbed fighter in their air defense units, while limited all-weather versions of the supersonic, swept-wing, twin-jet MiG-19 Farmer now are the mainstays of the Egyptian and Iraqi fighter forces. Farmers also have been shipped to Cuba. Russia has exported 12 late-model MiG-17 Fresco fighters to Morocco and Badger twin-jet bombers to Indonesia.

Zeus Production

Intensive Soviet effort in intercontinental missile defenses, coupled with U. S. progress in missile defense techniques, may result in early production for the Nike Zeus antimissile system. Defense Department is expected to recommend to President Kennedy that the Fiscal 1963 budget, now being prepared, include money for initial production without waiting for results of coming tests in the Pacific.

The decision is based on recent advances in missile detection, discrimination and data processing—plus growing evidence of an all-out Soviet effort in the missile defense field. One important aspect that concerns Administration officials is the propaganda advantage that would fall to the first country to demonstrate capability to kill an incoming hydrogen warhead.

Decision that the director of Defense research and engineering's office has to approve initiation of research studies has reduced the flow of Study Requirements to a trickle—not, apparently, because proposed studies are being turned down but because the reviewing process is so slow.

Space Center Scramble

Scramble for National Aeronautics and Space Administration's new $60-million manned space flight center has been joined by the President's home state, Massachusetts. Texas, Florida, California and Louisiana already have bid for the facility, and Virginia has been fighting hard to keep the nucleus of the manned flight group right where it is—in Virginia at Langley Field.

Because he is chairman of the subcommittee which considers NASA's money requests each year, Rep. Albert Thomas of Texas has had a powerful edge in the fight. But there are rumors that his health is so poor that his influence on key NASA, defense and atomic energy committees will cease to be a consideration. Recently, he issued a statement for Texas constituents saying his doctor has found him sound despite recurring prostate trouble, and "unless I get beat I'll be running 15 years from now."

Defense Secretary Robert McNamara, who has leaned toward service unification in the past, has about concluded that the way to keep any service from running away with the bit is to play them one against the other, and this has altered his ideas about the desirability of having only one service.

Snap Acceleration

A major acceleration of development work on Space Nuclear Auxiliary Power (Snap) reactors is planned by the Atomic Energy Commission. Emphasis will be on reactor-powered units rather than the radioisotope type now orbiting on Transit IV-A, and the reactor type may be ready to use with a space vehicle by the spring of 1963.

Uses will include power for transmission of data from soft lunar landing packages, for shore-based and floating marine navigation lights, and for unattended remote weather stations.

Criticism over the appointment of Army Gen. Maxwell Taylor as military adviser to the White House drew a parenthetical comment from President Kennedy at his press conference last week, but it was hardly a full explanation. "Now, when General Taylor was appointed, it was regarded as a diminution of the responsibilities of the Joint Chiefs [of Staff], which it is not," the President said. "But it came about as a result of a conversation between the Joint Chiefs and Secretary [of Defense] McNamara."

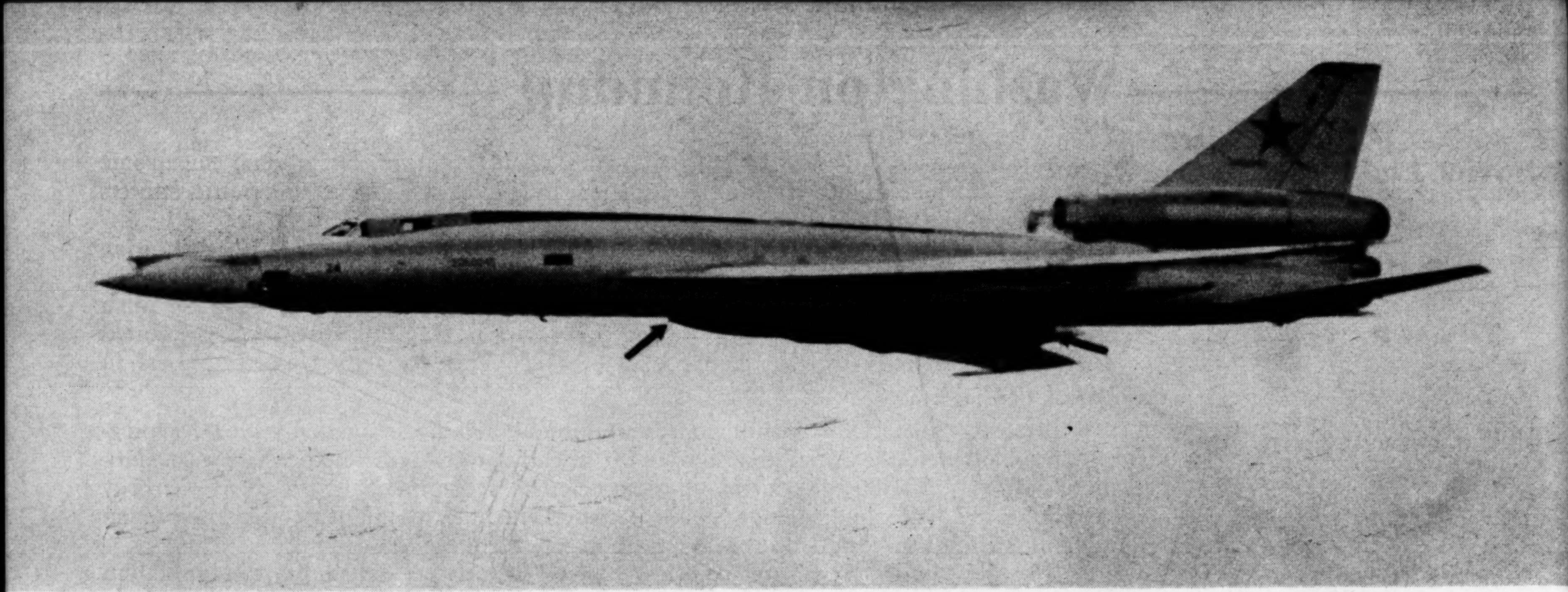
More Patent Hearings

Hearings designed to work out a federal policy on rights to inventions made under government contracts are scheduled to resume late next month. Chairman Emilio Daddario of the House Science and Astronautics Patent Subcommittee says agreement is broadening on an over-all government policy. Key to success, he said, is flexibility rather than the current set of rigid and confusing rules, and he feels a flexible patent policy is slowly but surely evolving.

State Department and foreign service employes crossing the North Atlantic by jet aircraft will be required to travel economy or tourist class, beginning Aug. 15. Expected saving is $300,000 per year.

Sen. Henry Jackson's hearings before his subcommittee on national policy machinery will bring two former fiscal experts back to town—Wilfred J. McNeil, who was Pentagon comptroller under Presidents Truman and Eisenhower, and Maurice H. Stans, who was President Eisenhower's last director of the Bureau of the Budget.

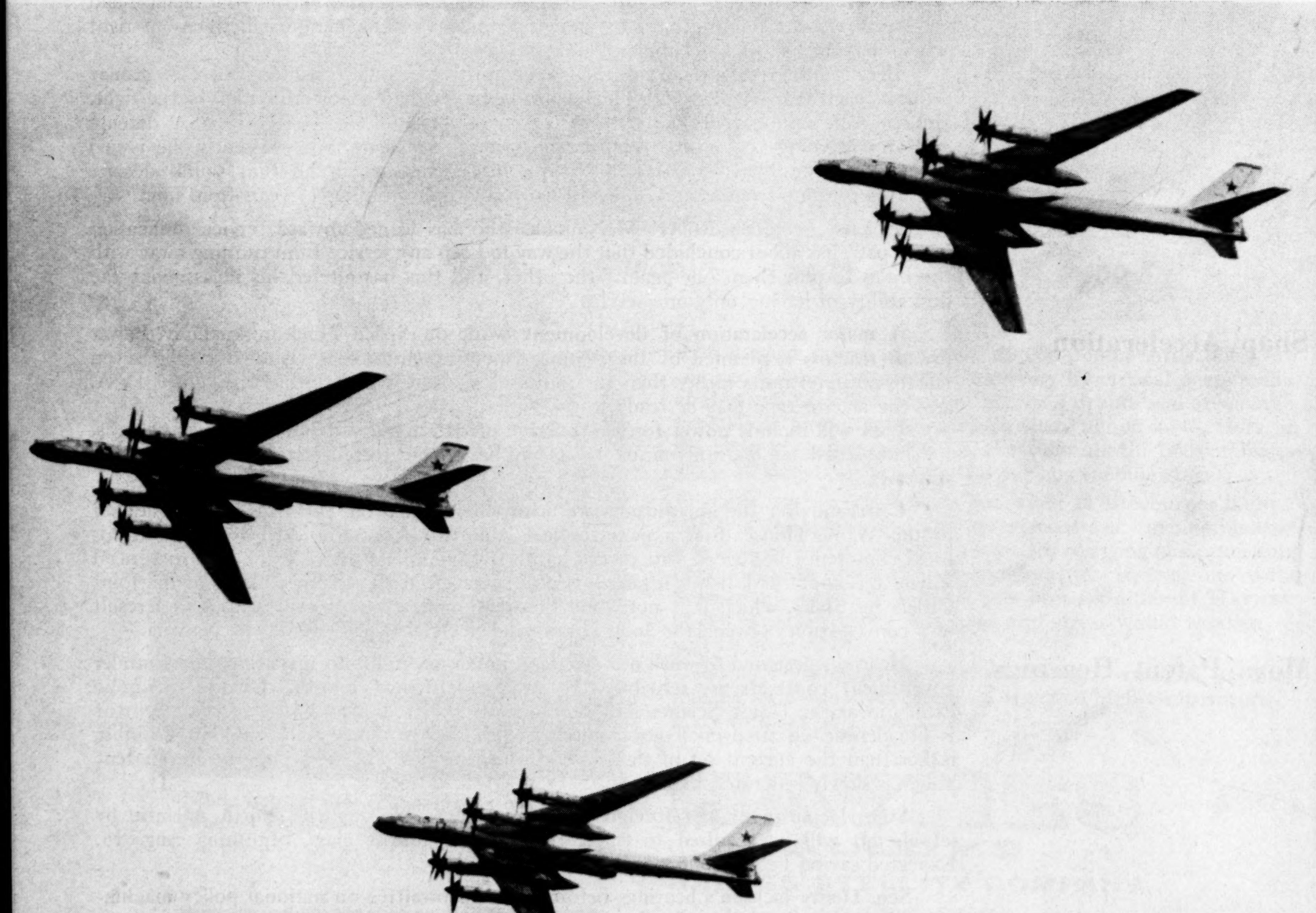
—Washington Staff

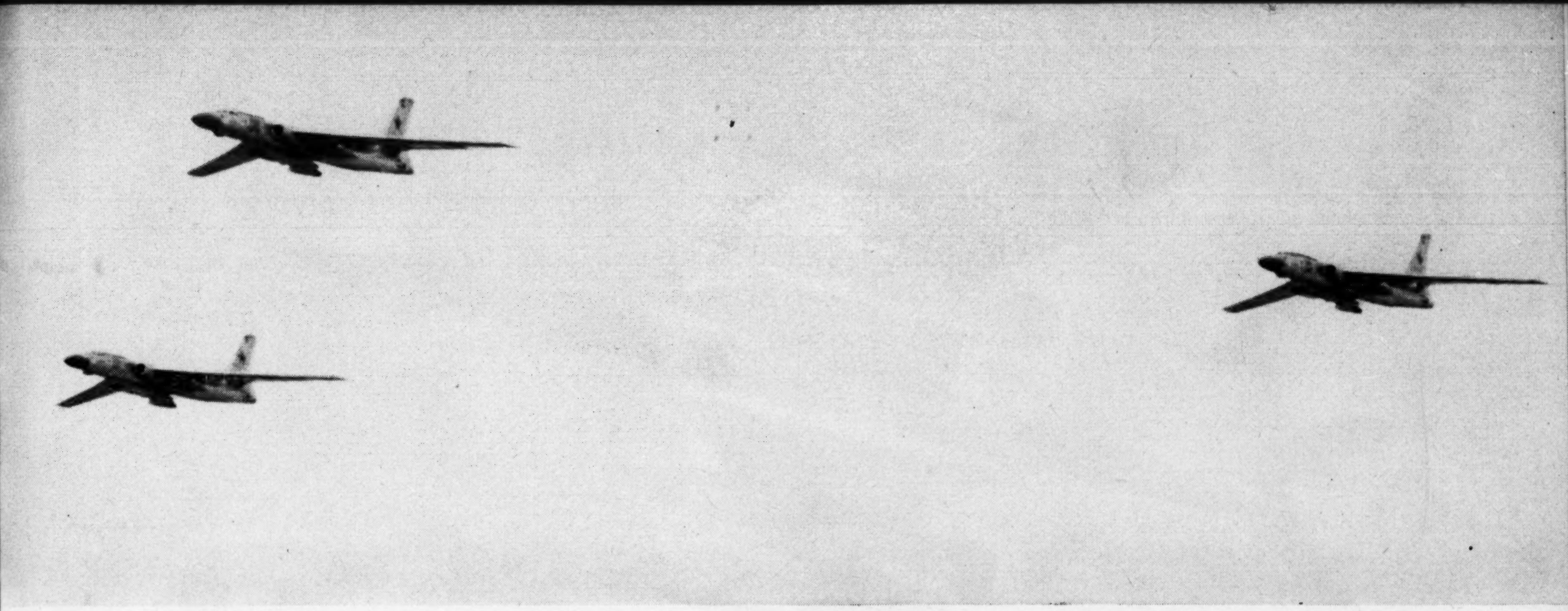


Beauty Mach 2 heavy bomber carries a ballistic type missile similar to USAF Skybolt slung under its belly (note arrows) during Tushino air show. Missile is rocket-propelled, about 65 ft. long and is partially housed in the fuselage belly with the underside of the missile and its truncated delta tail fins visible. Missile range is estimated at over 500 naut. mi. at supersonic speeds.

New Air-to-Surface, Air-to-Air Missile Types Are

Formations of Bear long-range turboprop bombers flew over Tushino equipped with large supersonic, radar-guided air-to-surface missiles slung under their specially modified bellies. Bear nose, formerly plexiglass to house bombardier, has been modified to solid radome for missile guidance. Bears carry operational squadron identification numbers on nose with No. 43 on lead plane and No. 17 on bottom plane.

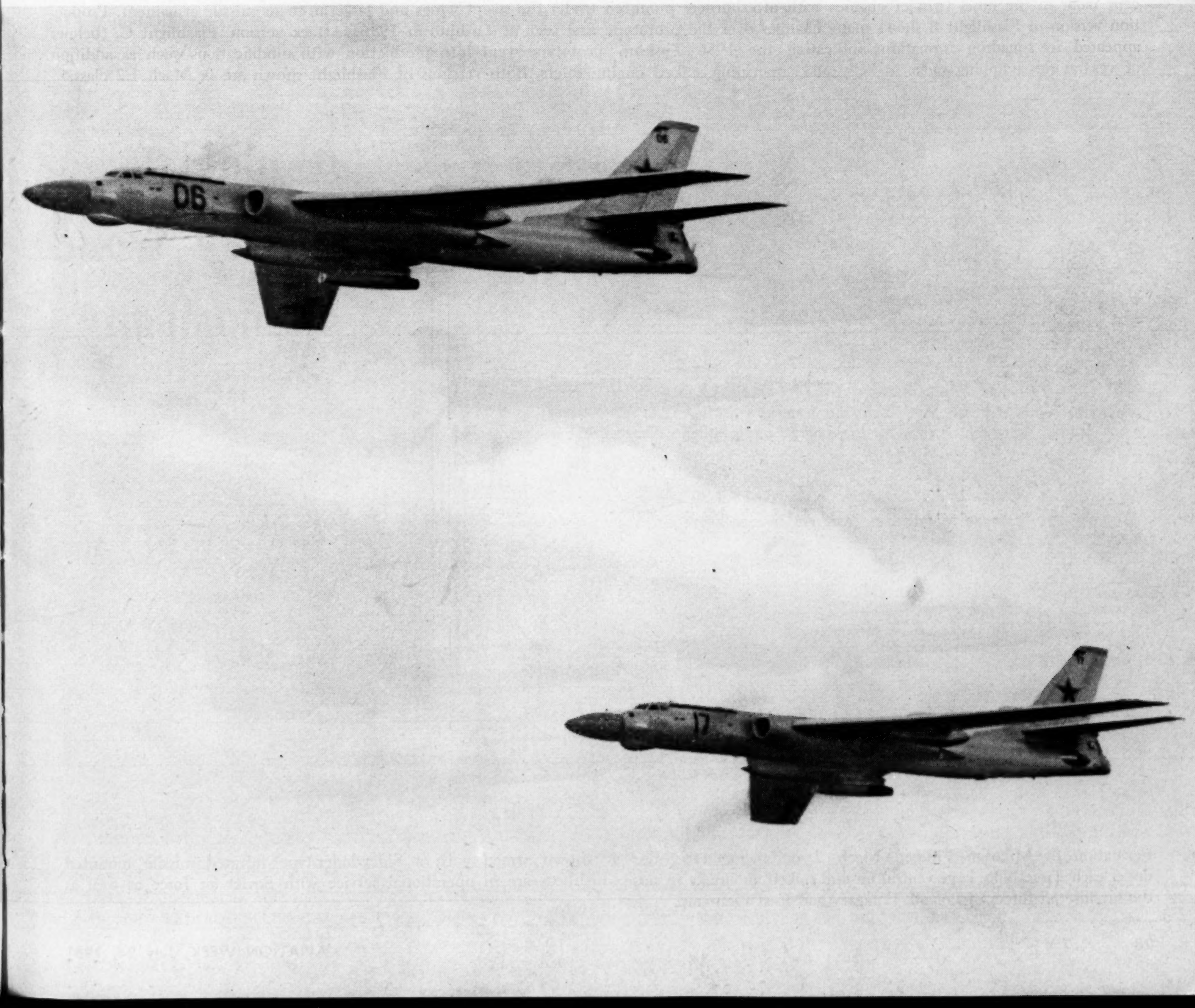


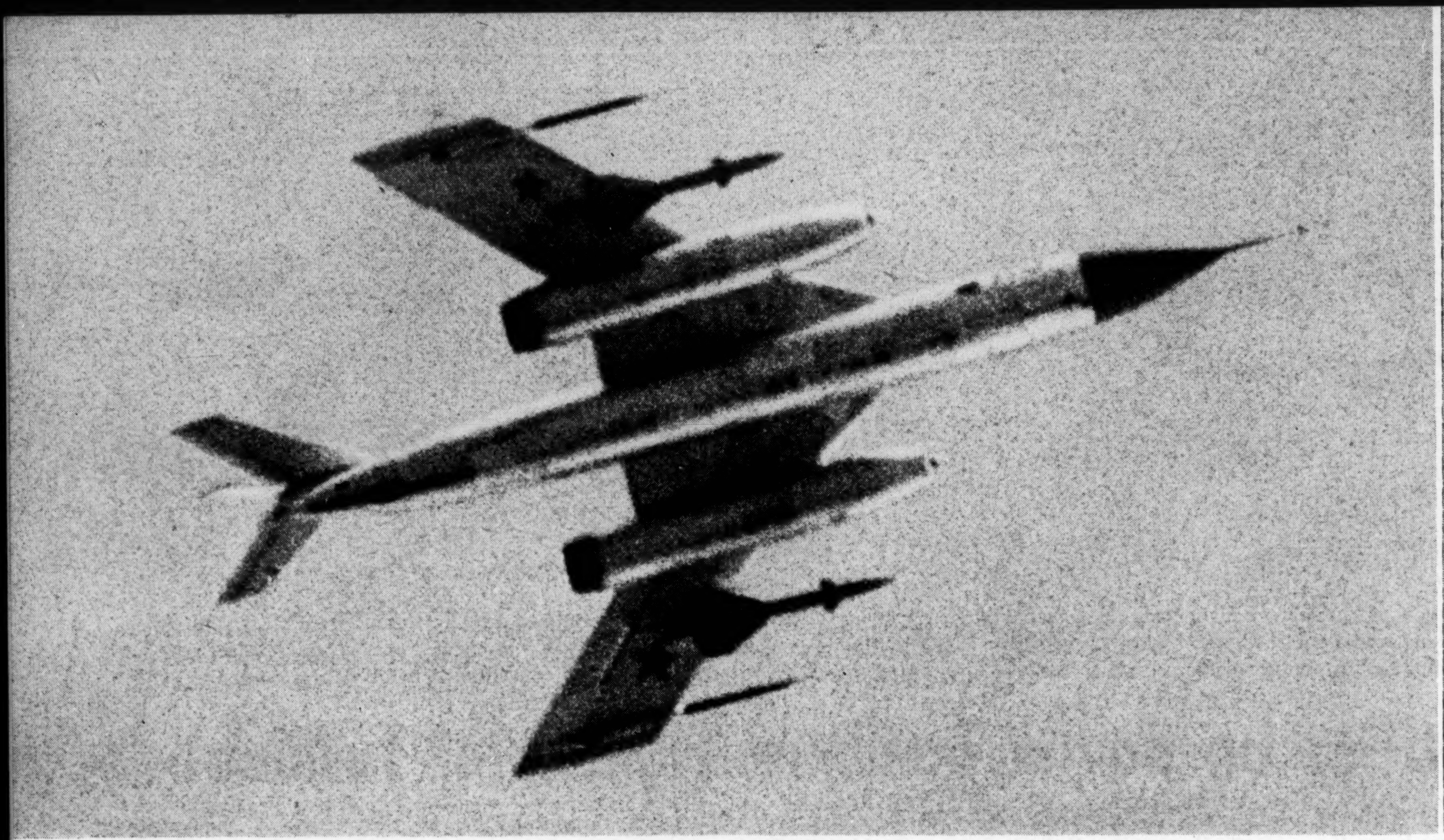


Formation of Tupolev Badger twin-jet bombers shown carrying air-to-surface missile resembling USAF Hound Dog design with jet engine slung under missile body. Maximum effective range of this jet-propelled missile is estimated at about 250 naut. mi. Badger nose has been modified to house guidance radar. Badgers, operational since 1955, formerly relied on conventional bomb delivery systems.

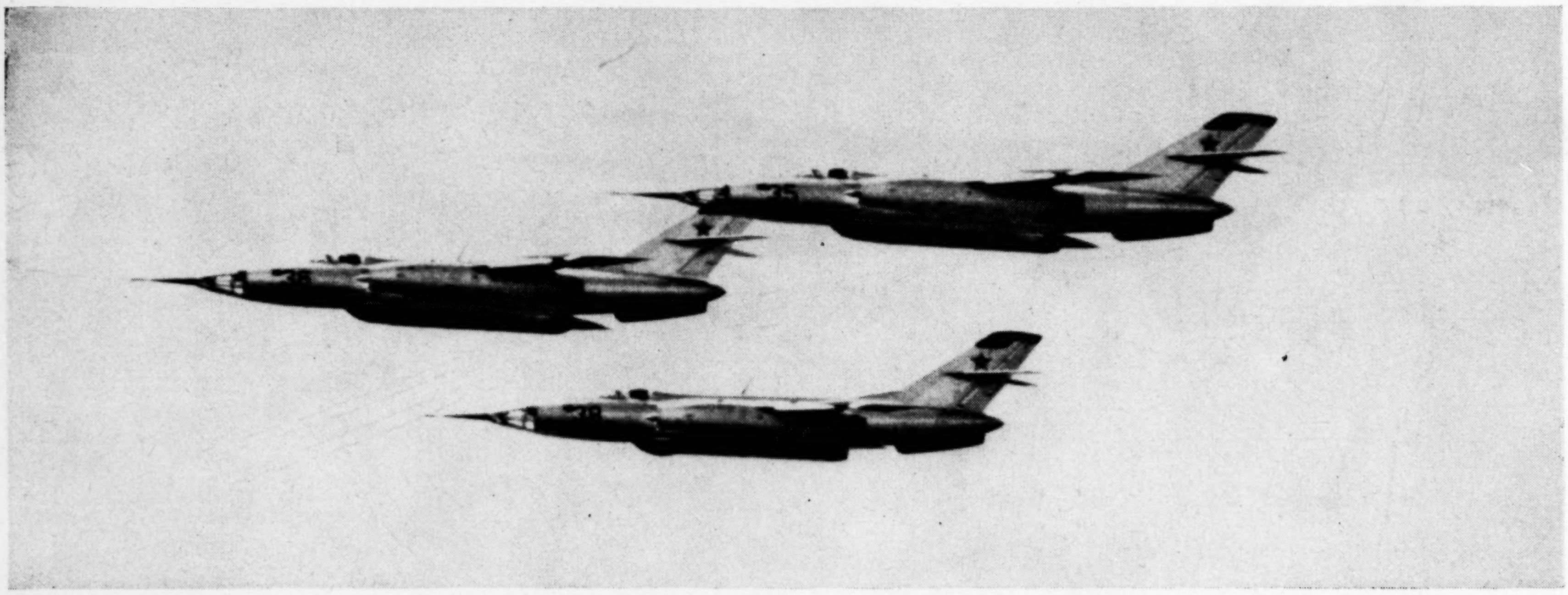
re dentified on Soviet Bombers, Fighters at Tushino

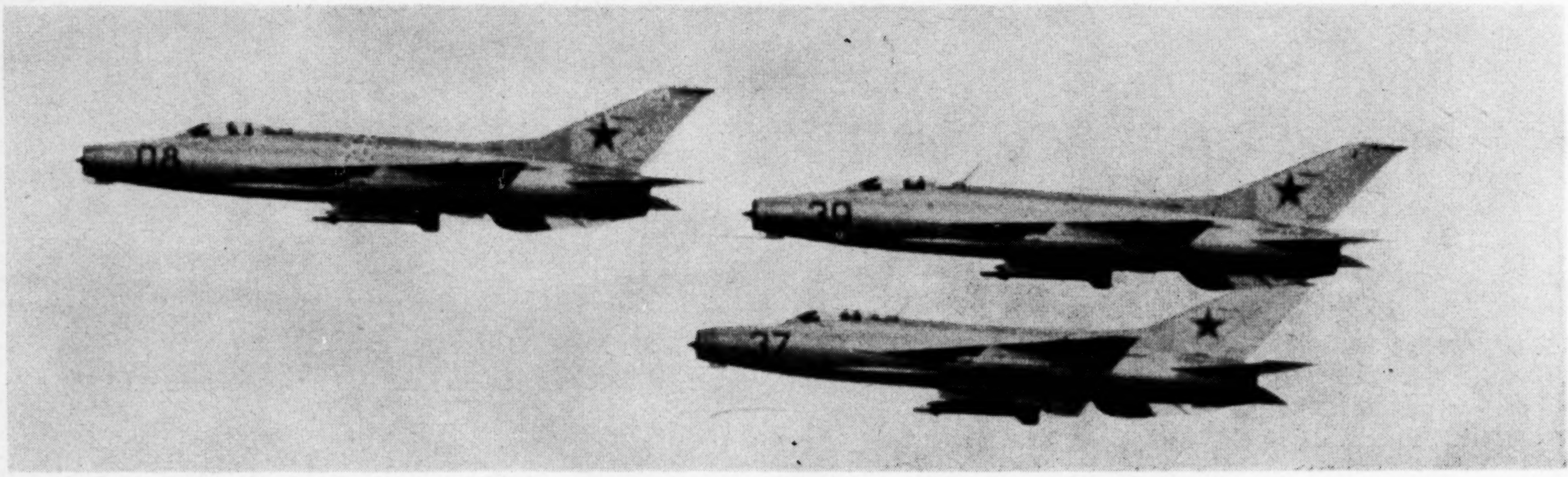
Close-up of the missile-carrying Badgers shows design details of the Hound Dog type missile and the new radar nose of the twin-jet bomber. Formations of missile-carrying Badgers flew at Tushino indicating the missile-bomber combination is in operational service.



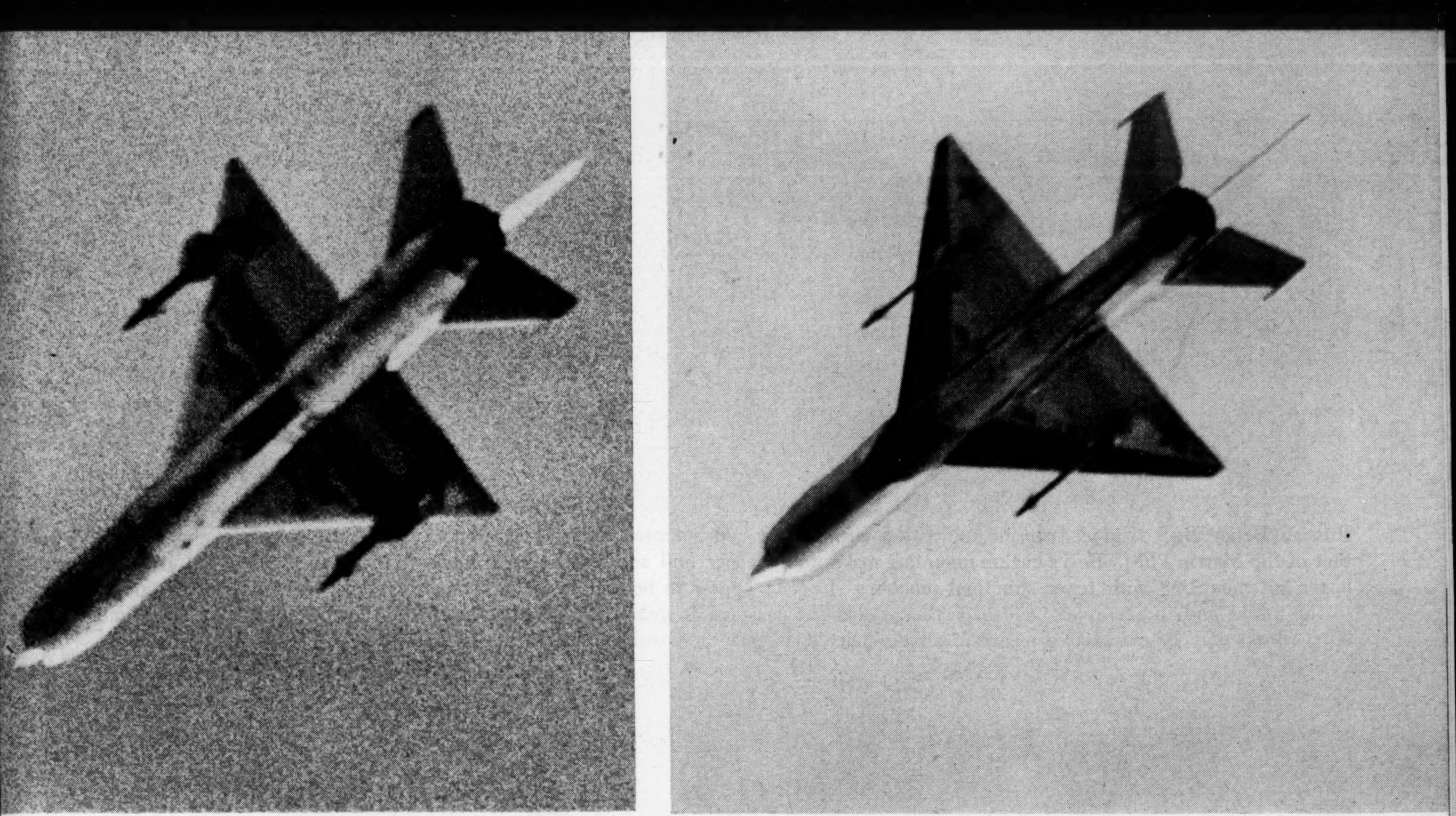


Two advanced versions of Yakovlev Flashlight series include the Model B (above) all-weather interceptor equipped with large airborne intercept radar in the nose, twin-jet engines with afterburners mounted under the swept wings and large air-to-air missile armament. Production version of Flashlight B shows many changes over the prototype first seen at Tushino in 1956. Attack version, Flashlight C, (below) appeared in squadron formations indicating the 1956 Tushino prototype went into production with modifications such as addition of ventral fin, bombing radar in belly and supersonic spiked engine inlets. Both versions of Flashlight shown are in Mach 1.2 class.



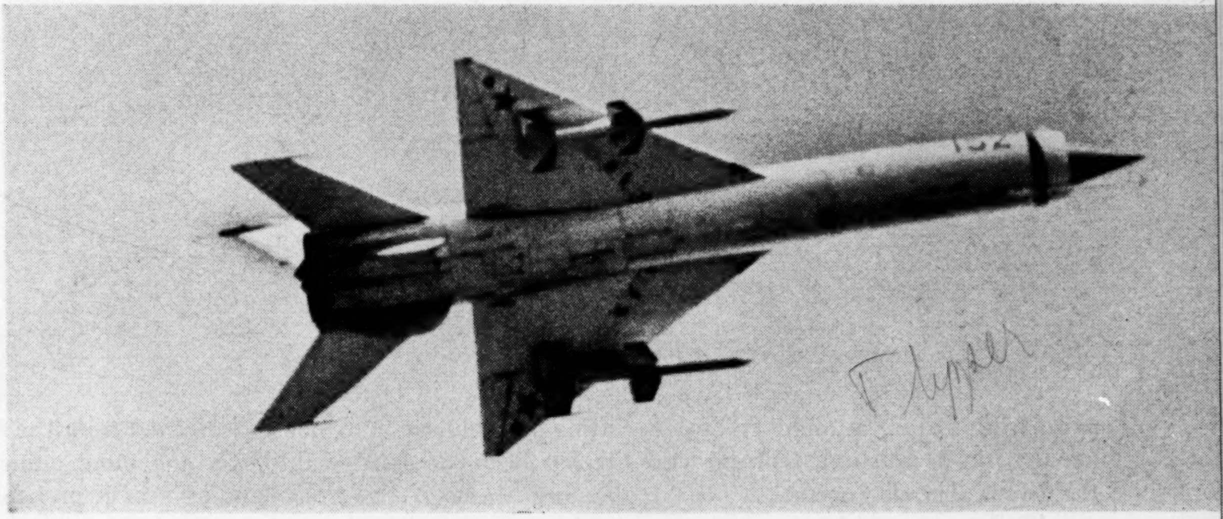


Formation of Mikoyan Fishbed Mach 2 delta-winged fighters is shown armed with a Sidewinder-type infrared missile mounted under each wing. Note large ventral fin and spiked air intake in nose. Fishbeds are in operational service with Soviet air force as well as the satellite air forces of Poland, Hungary and East Germany.

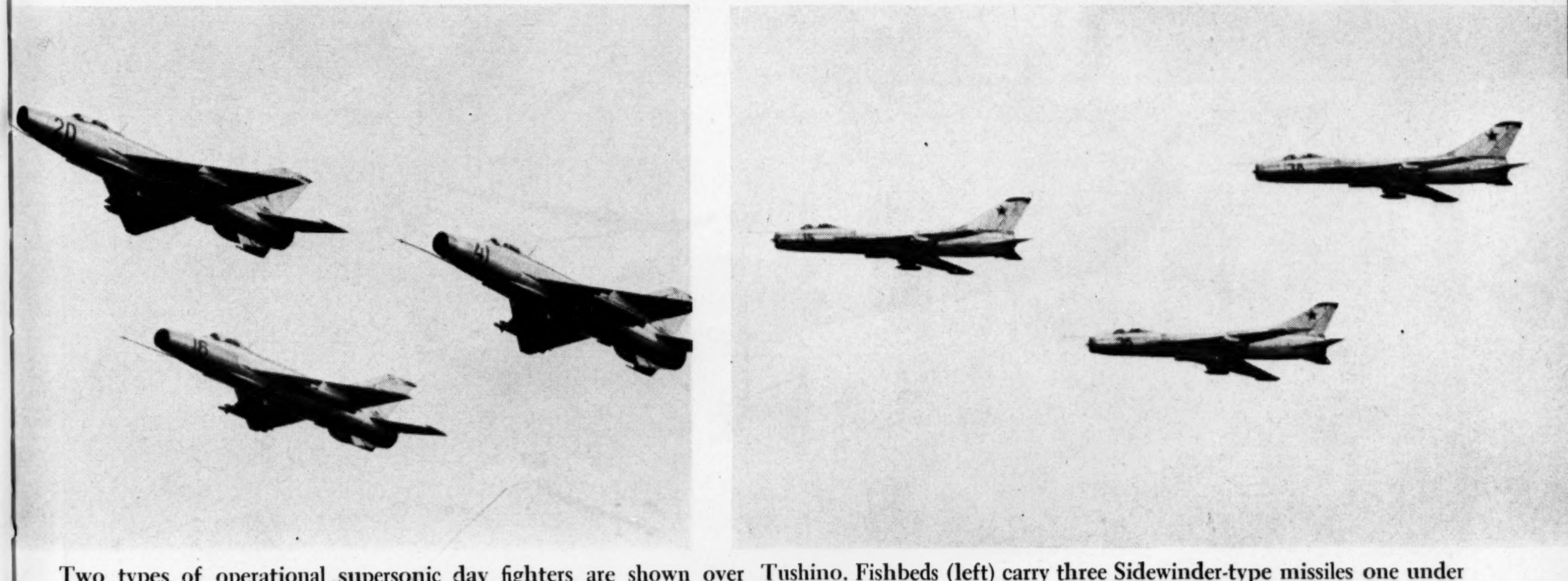


Two different Mach 2-plus prototypes (right and left) of new generation Soviet interceptors flew at Tushino. Both planes are apparently Sukhoi designs and feature a large single turbojet engine and delta wings but carry two different types of air-to-air missiles. Fighter at right has unusual paint scheme with red band along leading edge of delta wing and around mid-fuselage.

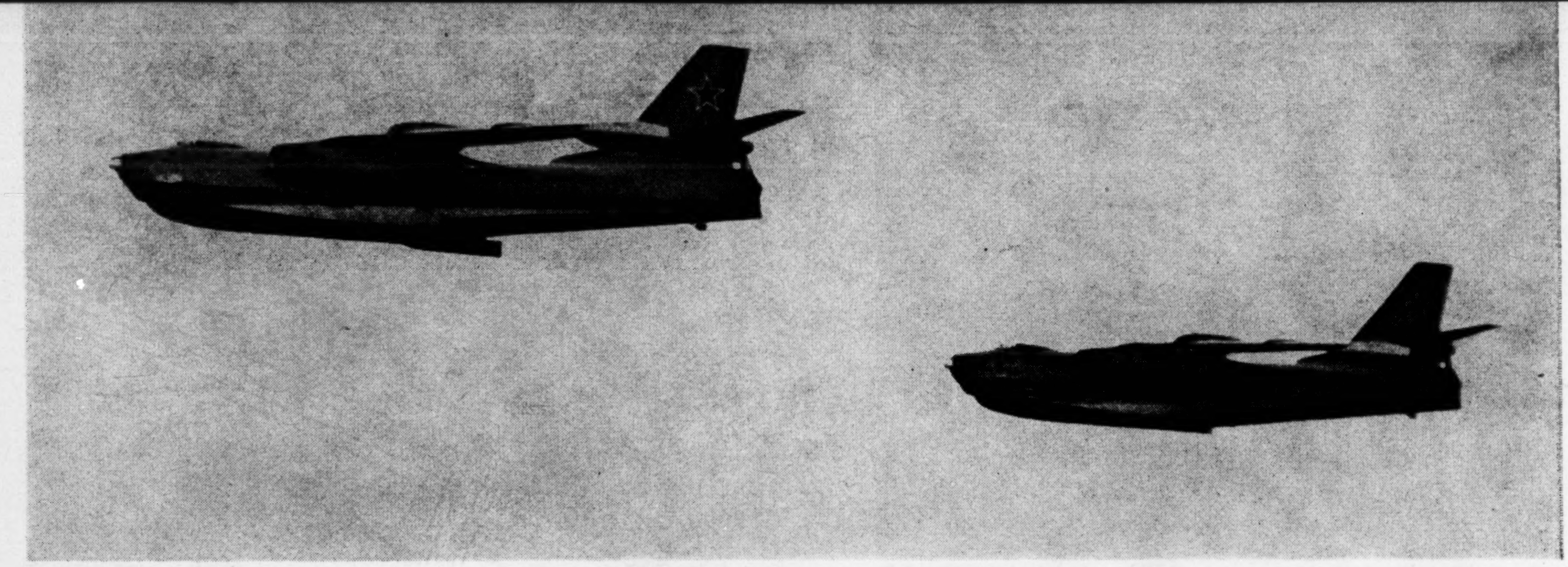
Soviet Fighters Show Varied Armaments



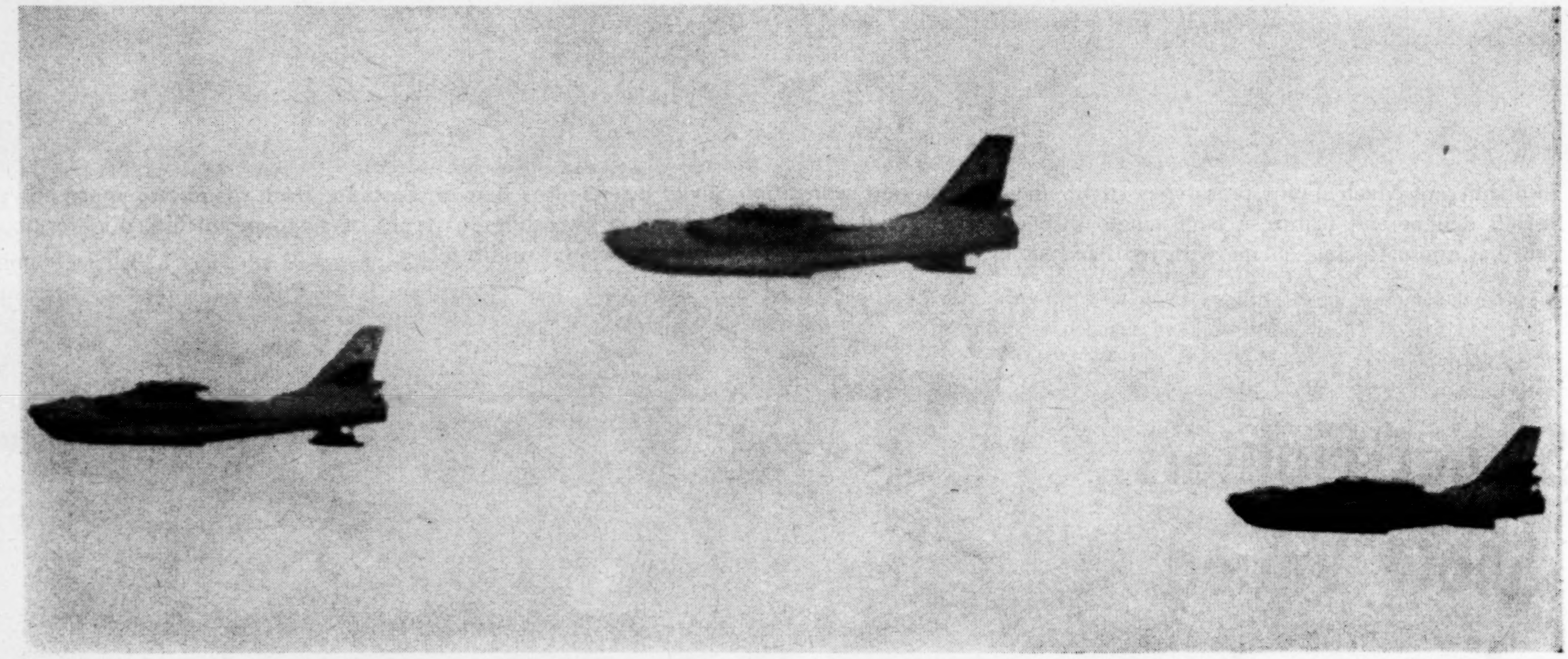
Both designs shown above differ from the new Mikoyan design shown here (AW July 10, p. 25 and July 17, p. 29) which carries another type missile and has two large turbojets with twin tailpipes and a rocket engine faired in between them at the tail.



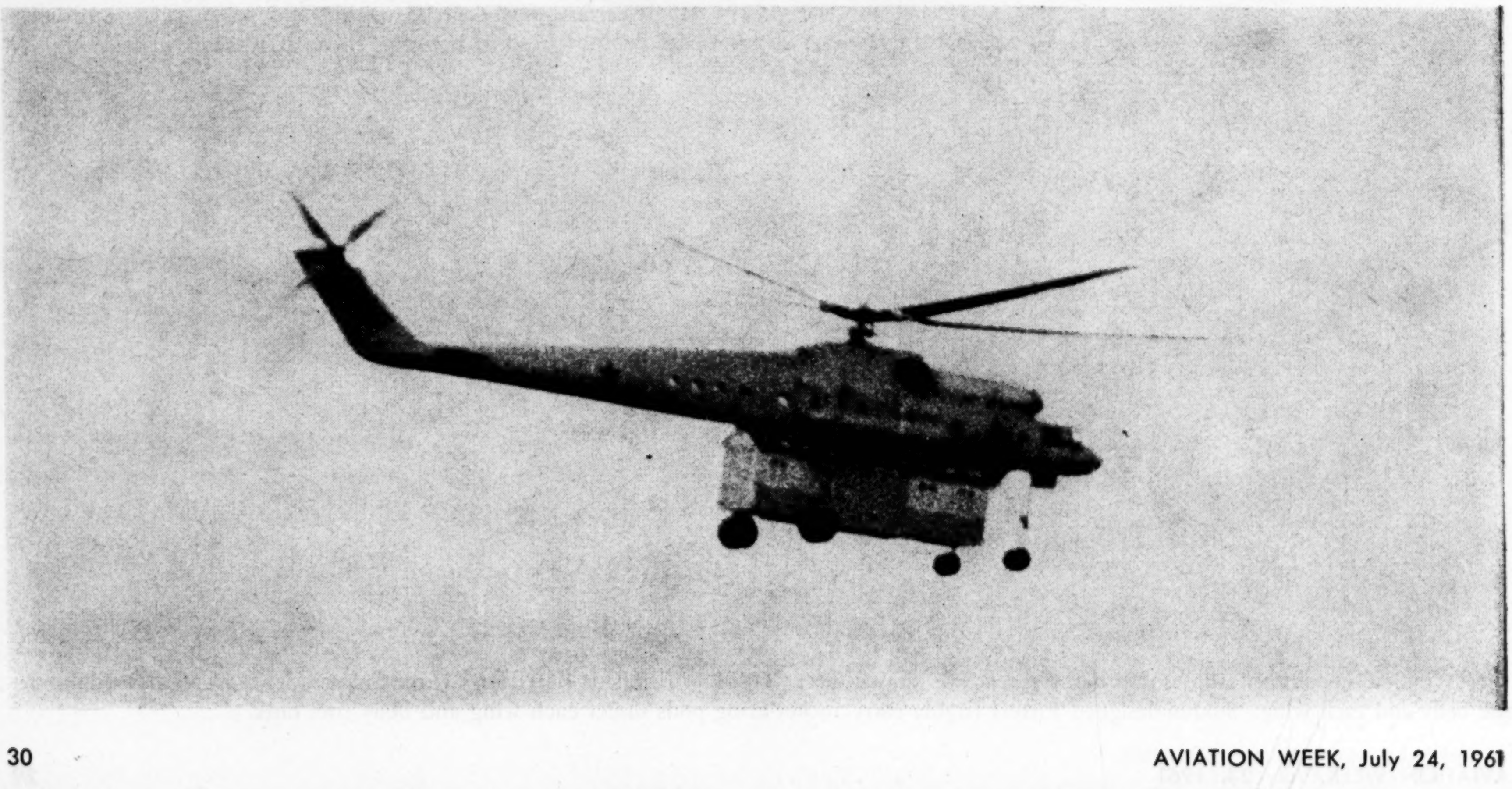
Two types of operational supersonic day fighters are shown over Tushino. Fishbeds (left) carry three Sidewinder-type missiles one under the belly and each wing. Sukhoi-designed Fitters (right) carry rocket-firing pods under each wing and belly fuel tank.

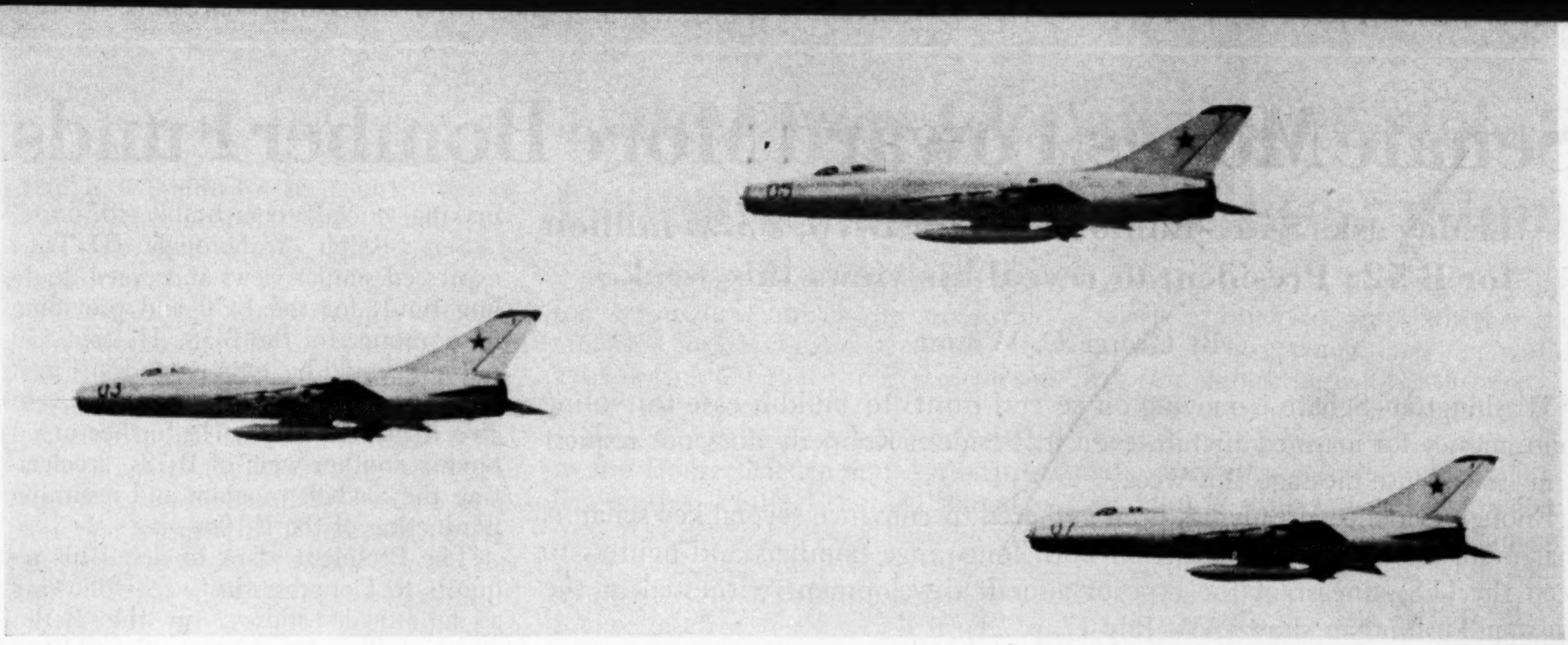


Russian Beriev Be-8 twin-jet seaplane underwing engines and mid-mounted horizontal stabilizer show contrast in design approach with that of the Martin P6M. Be-8's engine mounting makes for a deeper hull and less fuselage fineness ratio than the P6M, but permits the lower tail mounting with fewer structural problems. Engines appear to be mounted close inboard and the fuselage strake from the nose to the intake and the complex bow shape (below) may be designed to guard against water ingestion. Extension from fuselage under the tail (below) may be retractable magnetic airborne detection gear or possibly a door for mine laying or ejection of other stores.

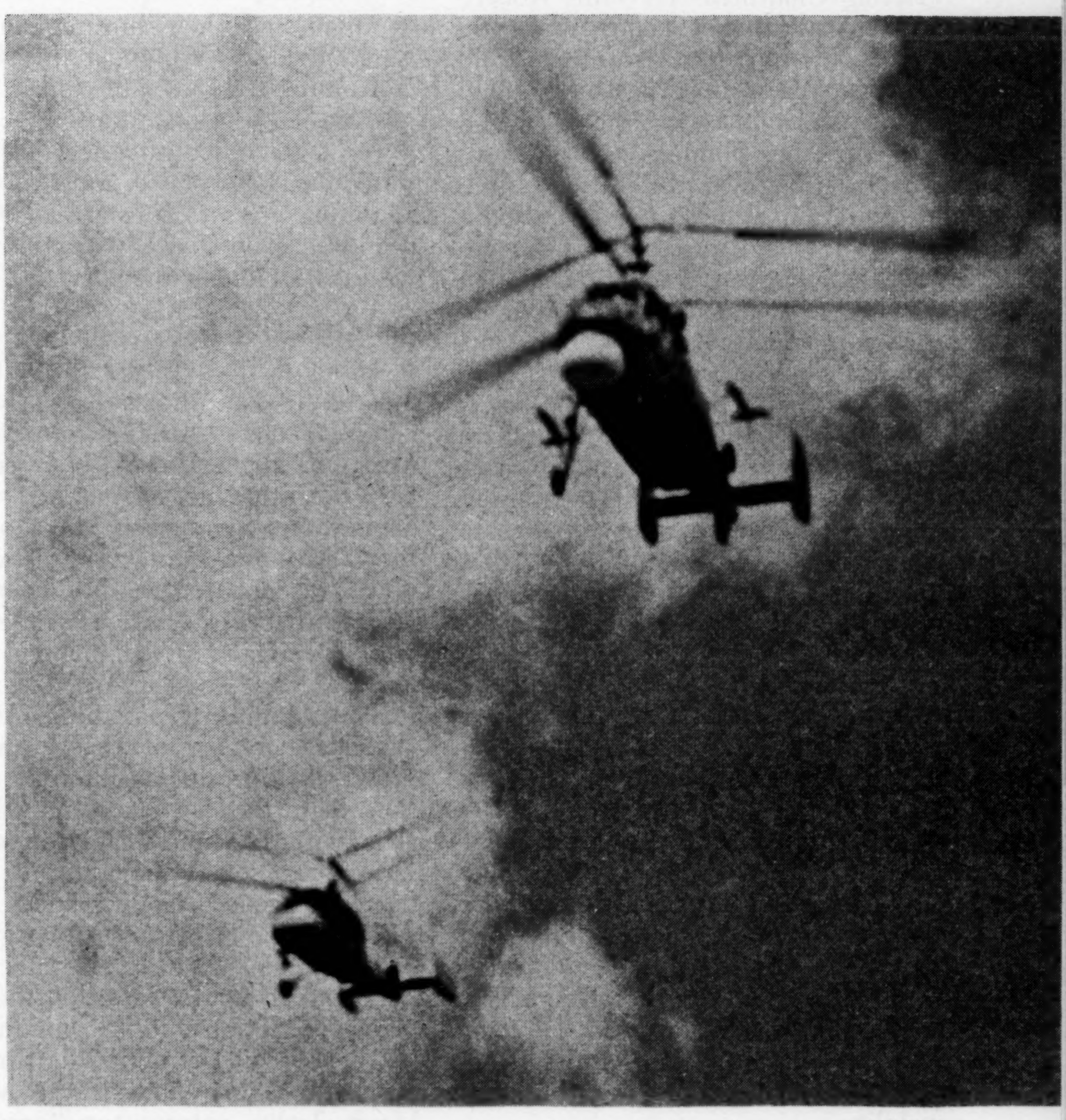


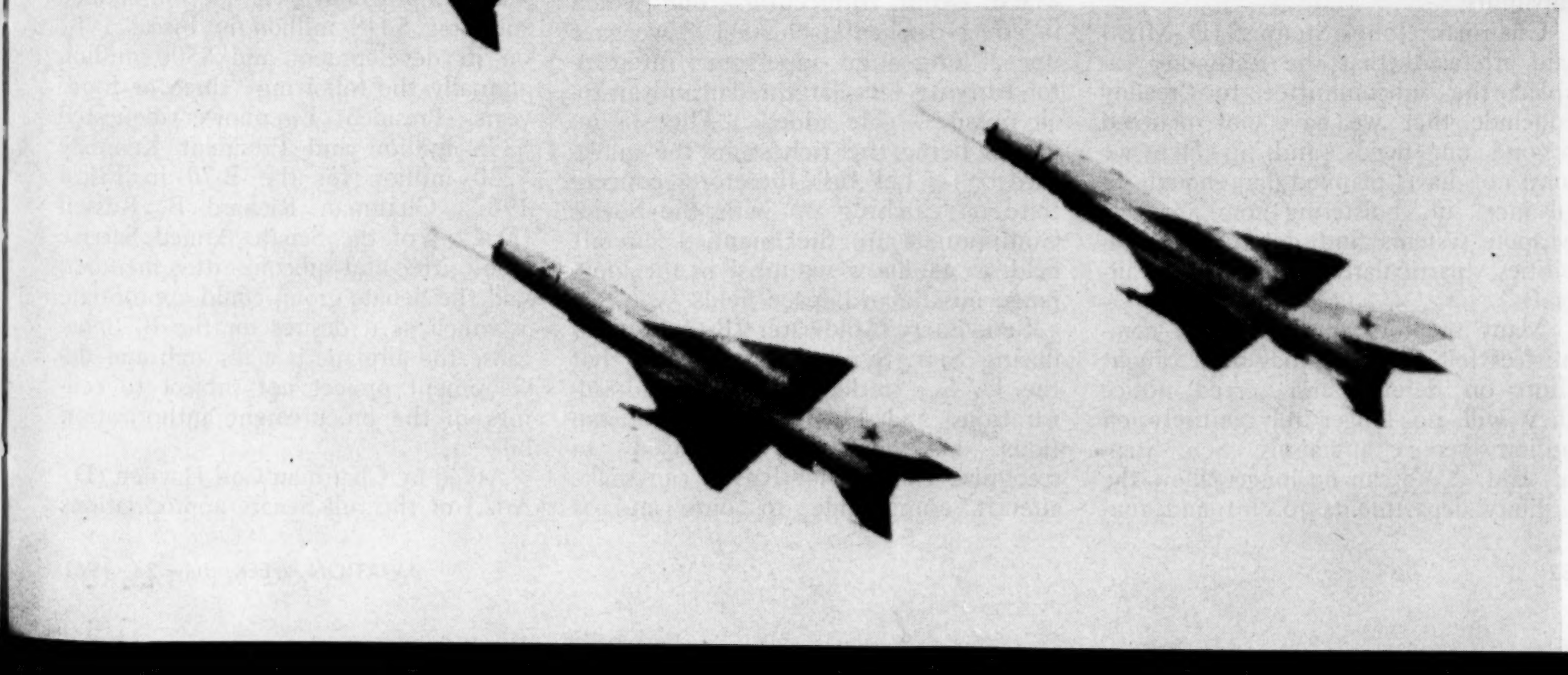
Mil Flying Crane, in flight at Tushino lifting a freight-car sized house, is derived from the Mi-6 but has a larger rotor hub and longer blades needed for its mission. Cockpit visibility has been increased with larger and more numerous windows and fuselage appears longer than the Mi-6. Circular extension below cabin just ahead of the front landing gear is probably a telescoping compartment for a crewman to provide aft viewing for cargo handling. This permits either forward or aft removal of loads.





Fishpots designed by Pavel Sukhoi (above) carry external stores that appear to be either auxiliary fuel tanks or rocket-firing pods. Fishpot first flew as prototype in 1956 Tushino air show and has been in production and operational service for several years as a day fighter. New Kamov turbine-powered helicopter is shown (upper right) with coaxial rotors, a large nose radome and two large air-to-ground missiles suspended from the landing gear on either side of the fuselage. Smaller piston-powered Kamov Ka-18 Hog (lower left) is shown flying formation with the larger jet-powered model. Kamov also designed the Hoop convertiplane shown at Tushino. Part of large Fishbed fighter formation (bottom) climbs away from Tushino during flyby in squadron-sized groups. Delta-wing planform and missile armament are visible in silhouette. Ventral fin also is visible.





Senate Moves Toward More Bomber Funds

LeMay asks $448-million total for B-70, $525 million for B-52; President to reveal his views this week.

By George C. Wilson

Washington—Senate is moving on several fronts to build a case for voting more money for manned aircraft, even if President Kennedy does not request it in his defense message this week.

Enough evidence already has been gathered to convince several key senators that more money must be spent on both long-range bombers and fighters to keep the U.S. abreast of the type of aircraft development witnessed at the Russian Tushino air show (AW July 17, p. 21).

Acting Chairman A. Willis Robertson (D.-Va.) of the Senate Appropriations Defense Subcommittee told Aviation Week he expects his group to vote new money for the B-52 and B-70 long-range bombers as part of an effort to strengthen the nation's military power in anticipation of a Berlin crisis.

Sen. Robertson, traditionally an economic conservative, even went so far as to call in Gen. Curtis E. LeMay, Air Force chief of staff, to rebut earlier testimony by Deputy Defense Secretary Roswell L. Gilpatric that there is no immediate need to spend more money on manned aircraft programs.

Gen. LeMay flatly told the Senate appropriations subcommittee that more and better manned aircraft are needed now and in the foreseeable future. He asked for $448 million this year and $500 million in each of the "three or four" subsequent years for the B-70, as well as $525 million this year for an additional wing of B-52s.

This same type of contradiction of earlier Kennedy Administration defense statements occurred behind the closed doors of the Senate Preparedness Investigating Subcommittee, which last week heard top officials, including Gen. LeMay and Director Allen W. Dulles of the Central Intelligence Agency, appraise U. S. military capability.

Chairman John Stennis (D.-Miss.) said afterward that the testimony enabled the subcommittee to "readily conclude that we have not planned beyond our needs, and, in fact, we may not have planned far enough in advance in bolstering our present weapon systems and deterrence capabilities, particularly in manned aircraft."

Many senators on both these committees felt the U. S. has been caught short on defense and served notice they will no longer rely entirely on military service appraisals. Sen. Stennis said: "We can no longer allow the military departments to 'hit and run' in discussing their funding and hardware needs. We must insist on a continuing review of our military posture."

In a reference to the Tushino air show, he said: "We must no longer allow ourselves to be startled by Soviet disclosure of new weapons—either manned or unmanned."

Senate Critics

Along with pleas within the two Senate subcommittees for a bolstered defense effort, several senators last week on the Senate floor criticized past downgrading of manned aircraft. Sen. Stuart Symington (D.-Mo.) cited the Tushino air show as an indication that "we apparently, by listening to Mr. Khrushchev, have now been outtraded seriously in the manned aircraft field."

Sen. Symington credited Aviation Week's coverage of the Tushino air show with producing "more information than the Soviets were willing to give out, in some cases more than various agencies, including the Central Intelligence Agency, knew about."

Sen. Symington said "for some four or five years we have, in effect, been hoodwinked as to some of the major plans for Soviet military buildup." He said "perhaps the most startling" aircraft Russia exhibited is the Mikoyan Mach 2-plus interceptor—"one which in effect duplicates the F-108 we gave up, a long-range supersonic interceptor carrying very large radar and air-to-air missiles." He added: "There is no use in being the richest in the graveyard . . . Let us therefore concentrate on catching up with the Soviet Communists in the manned aircraft field, as we know we must in the long-range missile and space fields."

Sen. Barry Goldwater (R.-Ariz.) said during Sen. Symington's speech that the U. S. "under Republican administrations and Democratic administrations has repeatedly refused to recognize that Soviet Russia can make aircraft comparable to ours and is making aircraft comparable to ours."

Sen. Ralph Yarborough (D.-Tex.) expressed similar views and urged doubling funds for the B-70 and providing more money for the B-58. He said $50 million should be appropriated in Fiscal 1962 to start modifying the B-58 to give it greater range. He further urged buying another wing of B-58s, accelerating the Skybolt program and resuming production of the F-106.

The President plans to detail his requests to Congress this week following a nationwide address on the Berlin situation Tuesday evening. Sen. Henry M. Jackson (D.-Wash.) was among those predicting that the Administration will change past position and ask for more money for manned aircraft.

Sen. Jackson told Aviation Week the closed briefing of the Senate preparedness subcommittee indicated the U. S. is ahead of Russia in subsonic aircraft but that the Soviets are ahead in "intercontinental supersonic bomber research and development." Sen. Leverett Saltonstall (R.-Mass.), who also attended the briefing and is a member of the Senate Appropriations Defense Subcommittee, predicted the subcommittee would appropriate more money for manned aircraft, regardless of what President Kennedy requests in his defense message.

Although the main focus in the U. S. manned aircraft controversy was in the Senate, Chairman Overton Brooks (D.-La.) of the House Science and Astronautics Committee announced that his committee also is interested in the comparative air strength of the U. S. and Russia. He said the committee will hold hearings on the subject Aug. 1-3.

The Senate Appropriations Defense Subcommittee expects to begin acting on the military budget bill this week. Here are the highlights of Gen. LeMay's testimony before that subcommittee last week on manned aircraft needs:

- **B-70 program.** He recommended spending $448 million in Fiscal 1962 on its development and $500 million annually the following "three or four" years. President Eisenhower requested $358 million and President Kennedy $220 million for the B-70 in Fiscal 1962. Chairman Richard B. Russell (D.-Ga.) of the Senate Armed Service Committee and subcommittee member, said the Senate group could appropriate as much as it desires for the B-70 because the airplane is a research and development project not subject to ceilings in the procurement authorization bill.

Asked by Chairman Carl Hayden (D.-Ariz.) of the full Senate appropriations committee about the advantages of the B-70, Gen. LeMay said: "I think the main characteristic of this weapon system is its value to the country before the fighting actually starts. That is, if you only have missiles, then you have no flexibility."

Commenting on problems involved in optimum development and use of the B-70, Gen. LeMay said there are no "major development problems" with the airplane itself. He said there is some difficulty with the Midas satellite warning system which will be used in conjunction with the B-70 and other strategic attack systems, "But we can see the end" of that difficulty. "It looks like it is going to be successful." He said the first B-70 will fly in December, 1962; first wing, given adequate funds can be operational in the first quarter of 1967.

- **B-52 bombers.** He recommended spending the full $525 million authorized by Congress for long-range bombers on B-52s so the Air Force can add another wing of this aircraft. The House appropriated $448.8 million for procurement of long-range aircraft in Fiscal 1962, but did not specify which type should be bought. President Kennedy did not request any new money for long-range bombers in his review of the Eisenhower Fiscal 1962 budget.
- **B-58 bombers.** Gen. LeMay said despite earlier problems with this airplane, production changes had been made so that "there is no doubt in my mind that the airplane is going to be a satisfactory article." He said the Air Force considers the B-58 a long-range bomber, but Sen. Russell said Congress, in passing the procurement authorization bill, considered the B-58 a medium-range bomber. Therefore, the B-58 could not qualify in Sen. Russell's view for any of the $525 million.

Gen LeMay said he likes the B-58 but thinks the B-52 offers more airplane for the money. He opposed cutting off B-58 production before it is scheduled to stop, declaring cancellation would not enable the government to recoup "any significant number of dollars."

- **Fighters.** He recommended retaining 11 tactical fighter squadrons slated to be phased out of service, and re-equipping them with modernized F-105s. He said Air Force and the Army have reached agreement on the general design of the TFX tactical fighter, but the Navy still has not agreed. He said the basic disagreement is that the Air Force wants a fairly heavy and large fighter, while the Navy fears such an airplane would be too big for its carriers. He said a decision on the TFX will be made "within the next two weeks or so."

As for ground support capability, Gen. LeMay said "there is no question in my mind that we can properly support the ground forces now in any task that they want to undertake."

State Urges Globally Accessible Communications Satellite System

Washington—State Department called for a single "universally accessible" satellite communications system last week and noted that the President supports this objective.

Presenting the department's position to the House Science and Astronautics Committee, Philip J. Farley, special assistant to the secretary of state for outer space, said that "we would not wish a multiplicity of systems to limit the usefulness of all systems. . . . If more than one system emerges, we should try to ensure compatibility and inter-linking of the several systems to make certain that together they can achieve the unique global possibilities of this tool."

Farley also qualified that defense purposes—including communication to reduce the risk of war by accident, misinformation, or miscalculation—"may be sufficiently important and unique to warrant a separate system."

Meanwhile, the unanimous recommendations of the National Aeronautics and Space Council, headed by Vice President Lyndon Johnson, clarifying and formalizing the roles of government agencies and private industry in the development and operations of communications satellite systems were being reviewed last week by the President. The recommended national policy statement was completed at a two-hour formal meeting of the council July 14, the first formal session held since Johnson organized it. It was attended by Secretary of State Dean Rusk, Deputy Secretary of Defense Roswell Gilpatric, Atomic Energy Commission Chairman Glenn T. Seaborg, Attorney General Robert Kennedy, National Aeronautics and Space Administrator James E. Webb and Federal Communications Chairman Newton Minow.

Speed Is Secondary

Speed in achieving an operational satellite communications system should be a secondary consideration, Farley said. Although the U. S. should proceed expeditiously, Farley commented, "we have not placed 'time' at the top of our list because of the importance of matching early availability with maximum usefulness."

In directing U. S. efforts toward a global system, Farley observed that the technical design of the communications system should be capable of covering areas of light—as well as heavy—traffic. This would appear to indicate government participation for uneconomic operations.

"We should not think of this as a United States-oriented system but rather as a system that could meet the needs of other countries whether these needs involve communicating with us or communicating with each other."

The system design should also be aimed to "conserve rather than abuse the frequency spectrum," he said.

John H. Rubel, assistant secretary of defense for research and engineering, presented the committee with comprehensive military requirements for satellite communications, but emphasized that Defense plans to rely on commercial facilities. He said that exclusive military facilities will be established only when military requirements cannot be met by commercial facilities.

Military Requirements

Rubel listed military requirements for long-haul point-to-point service between major traffic centers and to remote operational areas with light traffic, and for mobile communications between fixed points and mobile stations or between mobile stations.

He placed operation of the Advent system, involving three 1,000-lb. satellites in synchronous orbit 22,300 mi. above the equator, "several years" in the future because of technical obstacles. The system would blanket about 90% of the earth with a communications system. The first Advent satellite, now being fabricated, will be ready to fly in an intermediate altitude test orbit "within a year," Rubel reported.

Sea launch of Advent is being considered because this could be accomplished from a point on the equator, eliminating difficult re-direction after launch.

Three other systems Rubel considered promising are:

- **Passive reflector systems,** such as Echo spheres or Project Westford (see p. 23) which is to involve 500 million small reflectors in orbit, spaced 500 to 1,000 ft. apart.
- **Low-altitude active** repeater systems employing 30-50 or more satellites in 2,000-5,000 mi. random orbits.
- **Medium-altitude systems,** with 8-12 stabilized satellites in each orbit, from 5,000 to 7,000 mi. altitude. Systems of this type would not require switching from satellite to satellite as frequently as with the lower orbit systems and could cover polar latitudes not covered by an equatorial system.

All of these possible systems, Rubel noted, "require much more development and experimental testing before an operational system can be confidently planned."

Package Plans Call for 3,900 Missiles

By Larry Booda

Washington—Air Force and Navy, ordered by Defense Secretary Robert S. McNamara to "cost out" entire nuclear weapon delivery programs through Fiscal 1967, have proposed that 3,900 ballistic missiles be ready for firing from the continental U. S. and from submarines by that year.

The proposals break down into 2,500 fixed Minuteman solid propellant intercontinental ballistic missiles, 415 mobile Minuteman missiles, 275 Titan liquid propellant ICBMs and 720 Polaris solid propellant missiles.

Cost of the programs through Fiscal 1967 would amount to $12.5 billion for fixed Minuteman, $2.9 billion for mobile Minuteman, $3.1 billion for Titan and $8.6 billion for Polaris.

These are the highlights of the first phase of "package" program costing undertaken by Assistant Secretary of Defense-Comptroller Charles J. Hitch to provide McNamara with guidance in making decisions concerning future weapon systems.

First phase of Hitch's studies were limited to what he calls "central war forces" which is revised nomenclature for long-range nuclear delivery forces. Second phase, which is due for completion by the end of this month, concentrates on general purpose forces. This is new terminology for what were formerly called limited war forces.

The first studies were confined to Air Force and Navy programs. The second series will cover Army and Marine Corps programs.

Although Hitch's principal effort so far has been to give McNamara tools for decision making, his long-range aim is a sweeping overhaul of the military budget-making machinery. Long-term civilian employes in the Defense comptroller's organization have privately expressed concern over the ordered switch from category budgeting to program budgeting.

Full effects of the changes will not be felt until the Fiscal 1966 budget year, when Hitch plans to have program costing identified down to every specific support area, with general support areas prorated among the programs. This was done generally in the first phase studies just completed.

Specific support cost areas are defined as including such items as fuel, other supplies and administrative costs. General support costs include everything else, such as costs of general government administration and costs of operating the service academies and enlisted training schools. All of these are in addition to direct program costs.

McNamara now has the phase one studies in hand, and they have been distributed to the Joint Chiefs of Staff for study and comment.

There is no assurance that the proposed programs will be accepted by McNamara and the President. Many of the studies are open to criticism as being technically deficient in their form and approach. Comments concerning these points will be produced from the staff work of the Joint Chiefs of Staff.

For aircraft delivery of nuclear weapons, the Air Force has proposed the purchase of 52 more Boeing B-52 long-range bombers. Under present funding, the purchases would have ceased at 728 aircraft, which is 45 aircraft per wing for 14 wings, plus seven backup aircraft per wing to take care of attrition and out-of-service time due to maintenance and overhaul.

The B-52 costing-out proposal, submitted before recent suggestions in the Senate that it would listen favorably to requests for additional funds for manned bombers, calls for buying another 52 B-52Hs. Currently authorized strength is 14 wings of B-52s. Air Force would get around this by having a training "unit" of replaced B-52Bs not identified as a wing but in effect an active combat unit. Thus, the total number of B-52s would be 780.

Central war force costs in Fiscal 1962 would amount to $7.7 billion for the Air Force and $2.074 billion for the Navy. Air Force costs would remain over $7 billion through Fiscal 1965, then drop to $6 billion in Fiscal 1966 and $5 billion in Fiscal 1967.

Navy costs would remain at $2 billion in Fiscal 1963, drop to $1.8 billion in Fiscal 1964, drop off to a little more than $600 million in Fiscal 1967.

The Air Force total in Fiscal 1962 includes $1.8 billion for aircraft, $2.9 billion for missiles, $3.8 billion for construction, $1.1 billion for operations and maintenance, $1.1 billion for military personnel, $1.4 billion for research, development, test and evaluation, and $2.8 billion for other items.

Principal programs are:

- **B-52.** Proposed cost would be $2 billion in Fiscal 1962, $1.5 billion in Fiscal 1963 and would decrease to $1.3 billion in Fiscal 1967. The aircraft are figured as costing $11.4 million each.
- **B-47.** In Fiscal 1962, $58 million would go into this smaller jet bomber program, dropping until Fiscal 1967 when only $15 million is projected. Total through 1967 is $1.82 billion.
- **Fixed Minuteman.** This is programed for $1.3 billion in Fiscal 1962, $2.4 billion in Fiscal 1963, $2.6 billion in Fiscal 1964, $2.8 billion in Fiscal 1965 and then rapidly drops off to $1.9 billion and $1.5 billion in Fiscal 1966 and 1967, respectively. Total over the span of years is $12.5 billion, for a missile cost of $5 million each.
- **Mobile Minuteman.** There is $200 million programed for Fiscal 1962, increasing to $270 million in Fiscal 1963, $585 million in Fiscal 1964, $945 million in Fiscal 1965 and dropping to $645 million in Fiscal 1966 and $264 million in 1967. Cost per missile is $7 million.
- **Titan.** Programing for Titan begins at $1.3 billion in Fiscal 1962, drops to $600 million in Fiscal 1963 and down to $260 million in Fiscal 1967. Cost per missile is $11 million.
- **Skybolt.** There is $89 million proposed for Fiscal 1962, with a rapid buildup to $325 million in Fiscal 1963 and a peak of $480 million in Fiscal 1964. It would then decrease to a little over $100 million in Fiscal 1967.
- **B-58.** Proposed cost is $170 million in Fiscal 1962, increasing to over $200 million in the years following for a total program cost of $1.2 billion.
- **Polaris.** Navy goal is 45 submarines carrying 16 missiles each. Development costs in the program for longer range versions would push the cost per missile to $12 million. With 29 Polaris submarines already authorized or requested, proposals are for 10 more in Fiscal 1963 and six more in Fiscal 1964.

As proposed by the services, the program estimates are far from refined. One official describes them as "drills" for the future, when costs will be more thoroughly pinpointed.

Service officers fear that there may be adverse public and congressional reaction to having the costs of expensive weapon systems revealed. Congress generally favors this approach however.

U-18 Type Inspection

Federal Aviation Agency is conducting flight tests of the Umbaugh U-18 gyroplane in Hagerstown, Md., after issuance of a Type Inspection Authorization for the aircraft.

FAA officials said extensive flight tests probably would be required, since the U-18 is the first autogyro to be submitted for certification in "many years."

Also under study by FAA's Flight Operations Division are pilot requirements needed to fly the rotorcraft. A ruling on this is expected to be issued concurrently with certification. The FAA said it is too early to determine if additional pilot ratings will be required, but added that there is no guarantee now that fixed-wing pilot ratings will be sufficient.

U.S. Navy Polaris starts down the Atlantic Test Range

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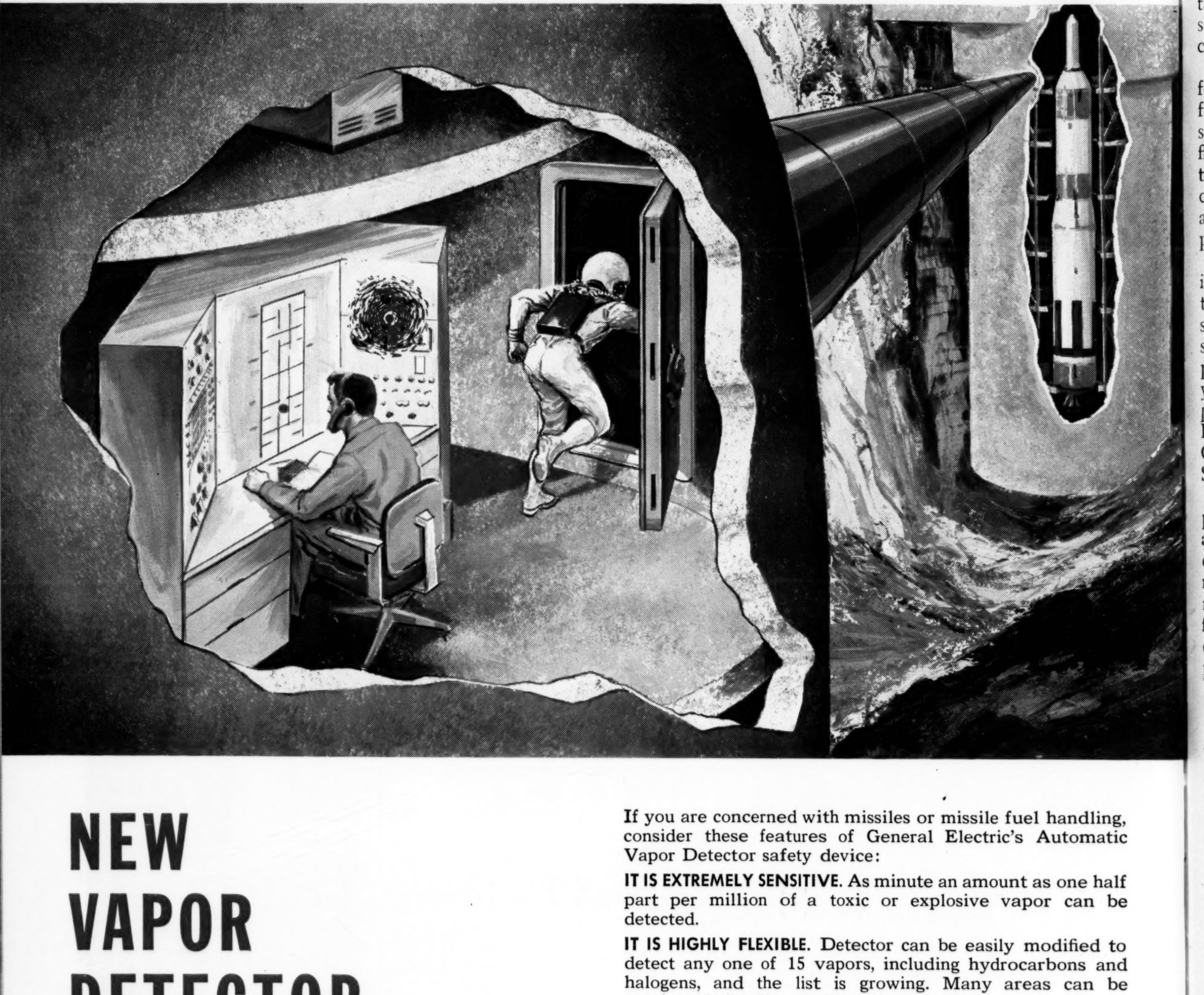

NEW VAPOR DETECTOR

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IT IS EXTREMELY SENSITIVE. As minute an amount as one half part per million of a toxic or explosive vapor can be detected.

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Conflict-of-Interest Rules Issued; 'Selling' Is Described by Defense

Washington—Defense Department issued its first broad conflict-of-interest regulations last week, including a detailed description of what constitutes selling to a service by its retired officers.

The new regulations bar any Defense personnel, military or civilian, from "any private business or professional activity" which involves a conflict of interest. They are also warned that, even if there is no technical conflict, "it is desirable to avoid the appearance of such a conflict from a public confidence point of view."

A retired officer is barred from selling, contracting for the sale or negotiating the sale of anything to his service "in violation of applicable statutory restrictions." His retirement pay can be forfeited if, within two years of retirement, he sells any "supplies or war materials" to the Defense Department, Coast Guard, Coast and Geodetic Survey or the Public Health Service.

Selling is defined as signing a bid, proposal or contract; negotiating a contract, or contacting an officer or employe of the Defense Department to obtain or negotiate contracts, negotiate or discuss changes in specifications, price, cost allowances or other terms of a contract or settle disputes concerning contract performance.

Further Limitations

The directive also bars any other "liaison activity" with "a view toward the ultimate consummation of a sale," even though the actual contract is subsequently negotiated by somebody else.

The section on selling notes that "it is not the intent of this directive to preclude a retired officer from accepting employment with private industry solely because his employer is a contractor with the government."

An officer who has served at least eight years before retiring or being released from his service, and who takes a job selling to a Defense agency, must file a detailed statement of his background and intentions with the secretary of the service with which he plans to deal.

The directive includes these other provisions:

- **Defense personnel** cannot accept any "favor, gratuity or entertainment directly or indirectly" from any person, company or organization involved in "procurement activities or business transactions of any sort" with a Defense agency where such favors might influence—or be interpreted as influencing—their impartiality. Any favor offered which might be interpreted as a bribe is to be reported immediately.
- **Civilian and regular** military personnel are barred from using their titles or positions in connection with any "commercial enterprise" or to endorse any commercial product. This does not bar writing books and articles as long as they have been cleared by the Defense Department.
- **Retired personnel** and reserves not on active duty can use their military titles in connection with commercial enterprises as long as such use doesn't discredit Defense or imply its endorsement. But the services have the power to restrict such personnel from using their military titles "in connection with public appearances in overseas areas."
- **Each military department** is to appoint an official to oversee these new regulations and ensure compliance.

Rickover Urges House To Abolish Air Force

Washington—Vice Adm. Hyman G. Rickover, director of the Navy's nuclear reactor program, has advised Congress to abolish the Air Force, accused the Navy of wasting money on aircraft carriers, said that National Aeronautics and Space Administration is uninformed on published Russian space developments, and charged that industrial corporations are stagnating technical progress with their patent practices.

In testimony before the House appropriations committee, released last week, Adm. Rickover also suggested that Congress is as capable of judging military programs as the military services.

"You do not have the rivalries . . . that exist in the military establishment," Rickover observed. "There the three services fight among themselves, each trying to set up spheres of influence for future exploitation . . . I know that past history shows many cases where Congress has pushed the military in directions they did not want to go, but which turned out to be right."

If USAF's Strategic Air Command were turned over to the Navy and its space and missile programs to the Army, Rickover observed, there would be only two instead of three "large groups fighting each other" and only two sets of installations, supporting facilities and personnel.

Adm. Rickover claimed that aviation officers dominating the Navy "would rather sacrifice anything else in order to get carriers." As USAF shifts from the airplane to the missile, Adm. Rickover said, the Navy is taking it over and "I am sure the Air Force does not object."

Although NASA Administrator James E. Webb and other top NASA officials have publicly stated they have no information on Russia's man-on-the-moon plans, Adm. Rickover said that unclassified literature presents Russian timetables for moon conquest.

Commenting that "NASA does not even have a central index of all its in-house and extramural research and development projects now in process," he added: "We are about to expend many billions of dollars in the space program. We must see to it that all information, U.S. and foreign, is immediately available. Otherwise there will inevitably be duplication, delay, and added cost."

Adm. Rickover credited Russian technical progress to its "capitalistic" practice of rewarding and stimulating individual inventors and making patent information widely available "to anyone who cares to look at and profit from it." Noting that 65% of all patents in the U.S. are awarded to corporations, he commented that "there is no such thing as collective thinking, as by a corporation. All thinking takes place in a single mind . . ." He also observed that Washington, D. C. is the only place in the U.S. where all patent information is available.

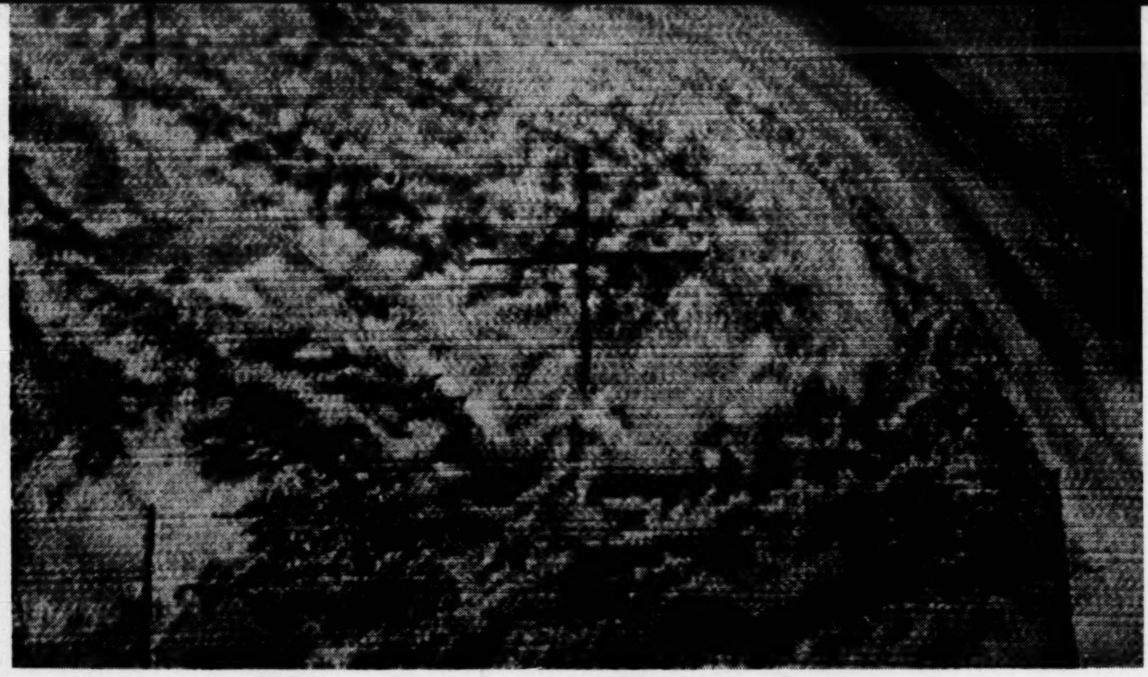
Noting that almost 100% of all the items in the naval nuclear reactor program are purchased on a "free enterprise" competitive fixed-price basis, Rickover added that "it is so pure and so capitalistic that some companies don't like it."

Swiss Bloodhound Order

Geneva—Swiss Federal Council, ruling body of Switzerland, has formally approved an army request to place a substantial order for Britain's Bristol/Ferranti Bloodhound 2 surface-to-air missile (AW July 17, p. 23). Final approval by Parliament, however, is not expected before the end of the year.

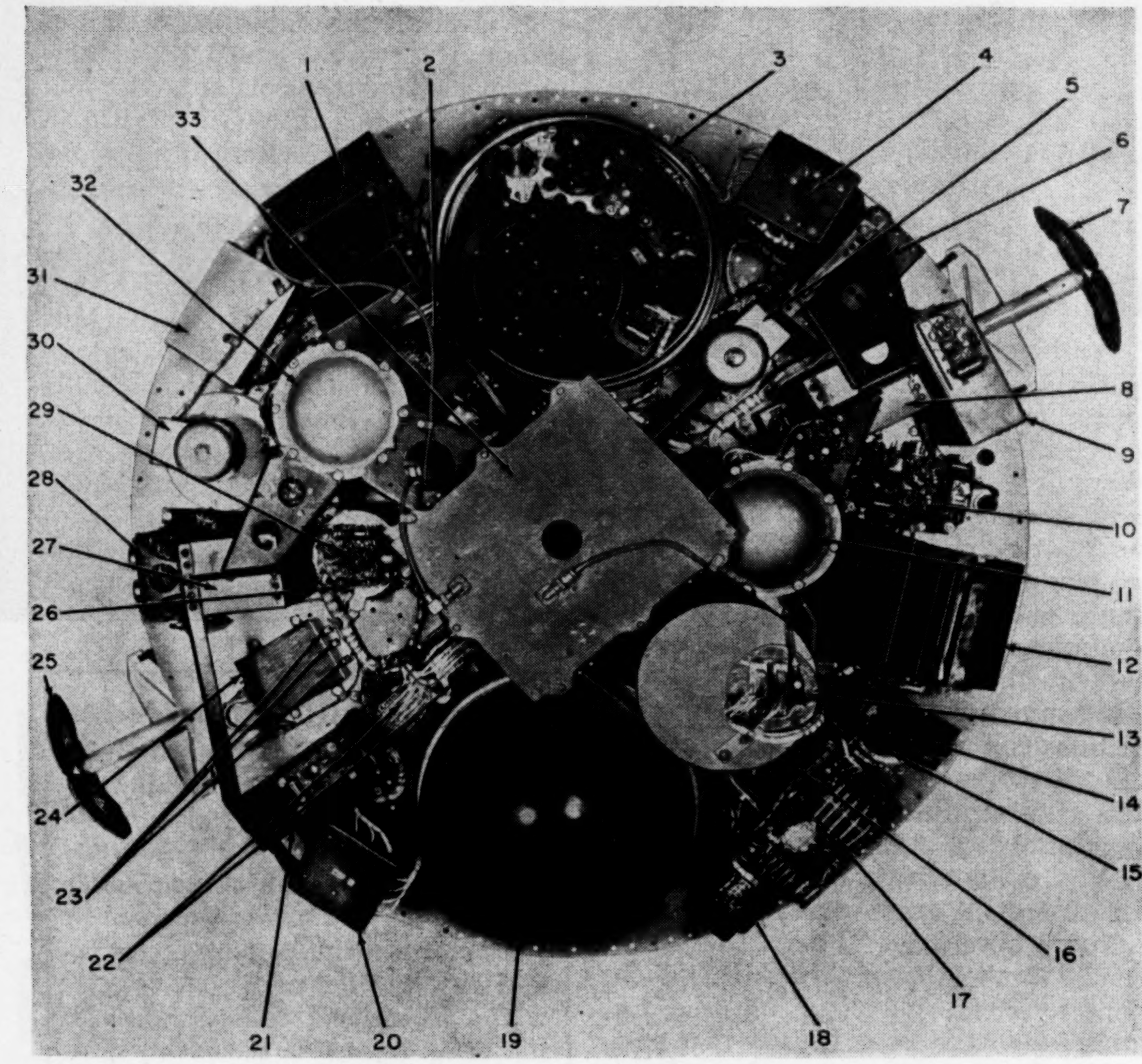
The Bloodhound decision, which is still being disputed in some army quarters, will provide the Swiss with their first tactical surface-to-air missile. It also apparently brings to an end Douglas Aircraft Co. hopes of selling the Nike Hercules to Switzerland as its standard antiaircraft missile system.

Although not officially announced, value of the Swiss order is estimated at approximately $80 million. British Aircraft Corp. spokesmen in England said only that it would be "somewhat larger" than the recent Swedish order for the Mark 2 Bloodhound.



Tiros III Scans West Coast

Coastal fog in northern California is visible in this picture taken about 12:45 p.m. July 14, on 34th orbit of NASA's Tiros III observation satellite. Photo is of the vortex of an old storm. Dark area at lower right is the California area around Eureka. The picture was received from the satellite at San Nicholas Island and transmitted to Pacific Missile Range.



Tiros III payload comprises: 1—television camera avionics package; 2—television transmitter power converter; 3—tape recorder (cover removed); 4—tape recorder avionics package; 5—television camera; 6—tape recorder power converter; 7—omni-directional radiometer; 8—television camera control package; 9—tape recorder power converter; 10—heat measuring equipment control panel and (below) command receivers; 11—electronic clock; 12—scanning radiometer; 13—heat measuring experiment avionics (and tape recorder) package; 14—horizon detector; 15—non-scanning radiometer; 16—voltage regulators; 17—battery protection panel and de-spin timer (below) and television transmitter (below); 18—television transmitter power converter; 19—tape recorder; 20—tape recorder avionics package; 21—tape recorder power converter; 22—main telemetry switches; 23—temperature sensors; 24—omni-directional radiometer avionics package; 25—omni-directional radiometer; 26—beacon transmitters; 27—auxiliary control package; 28—voltage regulator; 29—attitude control switch; 30—television camera; 31—sync generator and (below) television transmitter; 32—electronic clock; 33—antenna diplexer and (below) batteries.

GAO Charges USAF Spare Parts Waste

Washington—General Accounting Office has charged Air Force with wasting millions of dollars in the purchase of replacement units which it did not know it already had in inventory.

The charge, contained in a report to Congress, was based on an investigation of 650 of the 50,000 replacement equipment items in the USAF inventory.

These items, included in USAF's "Unit Authorization List," consist of equipment—such as aircraft ground handling equipment, test equipment, shop machinery, and generators—which has a long service life, does not lose its identity during periods of use, and is generally not incorporated as a component into other units.

The items reviewed by GAO represented $320 million of the total of $2.8 billion in unit authorization items in inventory. GAO found that $164 million worth of the items reviewed was not included in the inventory reports used in computing additional requirements and "not otherwise accounted for."

The report estimated that "over $6.7 million worth of replacement equipment purchased in Fiscal Year 1960 could have been avoided, and requirements for another $20.8 million, on which procurement was deferred principally for lack of funds, could have been eliminated, had the Air Force maintained effective control over the equipment procured and received in the supply system."

Conceding that its unit authorization listings "are incomplete and inaccurate, and do not adequately support . . . [USAF] in the computation of equipment buy-budget programs," the Air Force has notified GAO of numerous corrective actions.

These include the establishment at each base of a "Central Equipment Management Office."

Commenting that the steps taken and planned by USAF are "largely prospective," GAO withheld judgment as to whether they "will successfully overcome the serious and widespread problems observed by us."

As one example, GAO pointed to a generator set. A total 852 sets, valued at approximately $14 million, were not accounted for in inventory data. Of these, eight were at the Sacramento Air Materiel Area.

The Sacramento Air Materiel Area base computed a Fiscal 1960 purchase requirement of 266 sets. Purchase of 101 generator sets was deferred and procurement was initiated for 165 sets at an estimated cost of approximately $2.8 million.

Soviet Gravity Research

Washington—Efforts of Soviet scientists to understand gravitation "are so intense and unflagging that they warrant the closest continued watchfulness," according to a 389-page analysis of Russian research literature compiled for the Library of Congress' Science and Technology Section.

The report is available through Commerce Department's Office of Technical Services here. It was undertaken as a result of remarks made by Soviet professor of mathematics K. P. Stanyukovich in 1954 and 1957-58 about the possible "annihilation of gravitation." Stanyukovich is a member of the USSR Academy of Sciences' space commission and a professor at the Moscow Higher Technical School.

Eminent Soviet physicists have challenged his theories, and they delineate the current status of Soviet research on gravitation "with a measure of uncertainty and frustration," the report said. But a significant advance in the understanding and possible control of gravitation is "long overdue both in the western world and in the Soviet area—and could afford unfathomable potentialities to its discoverers," the study said.

First Ranger to Seek Earth's Hydrogen Tail

Washington—First Ranger spacecraft, forerunner of payloads that will rough-land instruments on the moon, is scheduled to be launched this week from Cape Canaveral. As one of eight scientific experiments that are considered secondary to testing of the spacecraft itself, Ranger will attempt to determine whether the earth trails a comet-like tail of hydrogen gas.

Ranger may travel more than half a million miles from earth before returning to burn in the atmosphere, or it may go into a solar orbit. For the first time in the civilian space program, the Atlas-Agena B launch vehicle will be used. The Agena stage shuts down for 13 min. after putting itself and the payload into an earth orbit and coasts in this "parking" orbit until it reaches the optimum point for restarting to begin the trajectory into deep space. This technique is not important to the first shot but will be used in lunar shots.

Ranger, one of the most complex payloads the U. S. has built, is being developed by NASA's Jet Propulsion Laboratory. It is hexagonal in shape, about 5 ft. in diameter at the base and 11 ft. long. With solar panels extended, it is 17 ft. by 13 ft. Of its 675-lb. gross weight, 144 lb. is scientific experiments, 243 lb. is electronics, 238 lb. is structural weight and the panels weigh 50 lb.

Ranger will test an attitude stabilization system that uses the sun and earth as references and 10 nitrogen gas jets for control; a high-gain steerable antenna; an advanced communication system; calibration of solar cells in space; and an experiment to determine friction forces of metal against metal in space.

The friction experiment is aimed at learning what will be involved in the operation of machinery with moving parts. Metals tend to stick to other metals in hard vacuums. The experiment consists of a motor-driven shaft with disks of different metals on it. Pressing against the disks are hemispheres of different material. Strain gages mounted on each hemisphere will telemeter to earth the drag force measured between each of 80 different combinations of metals.

Fuel Cell Test Vehicle Contract Won by GE

Washington—General Electric will build two space vehicles for 30-day Air Force tests of a 50-watt fuel cell battery in a 300-mi. orbit.

Aeronautical Systems Division has awarded an $882,600 contract to GE Missile and Space Vehicle Department to construct the two 100-lb. test capsules. Each will have a volume of about 6 cu. ft. and carry instrumentation to measure fuel cell performance and telemetry equipment, all powered by the fuel cell battery.

The fuel cell system, to be developed and built by the GE Aircraft Accessory Turbine Department, will consist of 30 individual cells. Output will be six or 28 volts. Hydrogen and oxygen will be the fuel for the ion-exchange membrane cells, and the chemical action of the two gases will produce both electrical power and water.

This experimental program is expected to contribute data that will be valuable in developing a 500-watt, 28-volt fuel cell system for space use.

News Digest

House and Senate last week agreed on a compromise bill authorizing the full $1,784,300,000 sought by President Kennedy for the National Aeronautics and Space Administration, increasing the amount for research and development and decreasing the construction budget. The compromise bill also authorizes increases to provide $10.2 million total for solid propellant development and $9.7 million for electrical propulsion.

Civil defense mission was assigned last week to Defense Secretary Robert S. McNamara. Former Office of Civil and Defense Mobilization will become the Office of Emergency Planning to plan continuity of state and local governments, natural disaster relief, defense mobilization and materials stockpiling.

RCA Astro-Electronics Division will build three ground test and four flight test capsules for ion engines for National Aeronautics and Space Administration. First launch using a Scout late next year will test a Hughes cesium-fueled engine and a NASA mercury-fueled engine.

French government has indicated its willingness to finance 50 of a requested 100 additional Sud Caravelle turbojet transports. The company wanted 100 authorized to raise production above the breakeven level of 225. Present production program is for 150 (AW July 17, p. 52).

North American T-39 flew from Madrid to New York in 9 hr. 39 min. elapsed time last week, claiming an unofficial long-distance speed record for its class. The 3,873-mi. flight included stops at the Azores, Argentina and Newfoundland, and average speed was 413 mph. A mix-up at New York's Idlewild airport prevented certification for an official record.

Frank Pace, Jr., General Dynamics chairman, has been appointed to the Foreign Intelligence Advisory Board to replace Gen. Maxwell Taylor, new White House military adviser.

Eastern Air Lines is exploring possibilities of promoting use of bus transportation in conjunction with its air shuttle service. First area is likely to be Cape Cod points to tie in with an Aug. 1 doubling of air shuttle schedules between New York and Boston with hourly flights. Idea is to fly Eastern to Boston, connect with frequent bus services to the Cape area.

Ground test Vertol YHC-1B helicopter was damaged during runup when the rotor blades went out of synchronization, struck each other, and damaged the upper fuselage. The aircraft is repairable. Cause has been determined and corrected. Three persons were aboard the helicopter and there were minor injuries.

Midas early warning satellite ground station will be built at Kirkbride, England under terms of a U. S.-British agreement. The missile warning system receiving station will be jointly manned by the U. S. Air Force and Royal Air Force during installation, then will be operated by the RAF.

Competition Forces Trunk Excursion Fare

Drive to fill growing seat capacity produces rate cut; may push coach business to more dominant position.

By L. L. Doty

Washington—Competitive drive for new business to offset the domestic trunkline industry's swelling seat capacity has forced introduction of the first major domestic excursion rate in recent years, which is expected to push coach traffic into an even more dominant position than it now holds.

Last week, Trans World Airlines filed a tariff with the Civil Aeronautics Board calling for a coast-to-coast jet round-trip excursion rate of $198 and piston-engine excursion rate of $178, lowest fare offered on this route in recent years. American and United later announced they would file a similar tariff. American bluntly stated it was filing only because it was forced to for competitive reasons.

United termed the excursion rate a "worthwhile experiment," which it hoped would create new traffic sources. The airline said it would "merchandise" the plan extensively.

Nevertheless, both United and American are known to be vigorously opposed to any further rate reductions at this time on the grounds that the volume of coach traffic already has grown beyond profitable proportions as a result of diversionary effects on first-class traffic.

Luring Highway Travelers

TWA feels the new fare will not lure passengers away from standard services but will draw new customers away from the highways (AW May 1, p. 38). The airline says this is achieved by requiring purchasers of excursion tickets to travel between Monday noon and Friday noon and to return not less than 13 nor more than 30 days after departure. Business travelers, TWA reasons, will find these conditions impractical.

American's philosophy is that before fares can be lowered to attract new business, there must be some determination that the business is there. American contends that there is a limit to any traffic market and that the lowering of fares for the available traffic only tends to slice gross revenues.

United has consistently held that the gap between coach and first-class rates has been too wide, and the carrier led a successful industry drive last year to increase rates to 75% of first-class fares. A move earlier this month by Braniff Airways to hike coach rates to 85% of first-class rates has been suspended by the Board.

Since June, 1960, when coach traffic equalled first-class in revenue passenger miles for the first time, coach has steadily climbed to account for 58% of all traffic handled by the trunk carriers in June of this year (see box).

In that month, National and TWA were the heaviest carriers of coach traffic by a wide margin. United ran a poor third among the 11 trunklines, and American stood in seventh place in that category. Only Delta and Braniff handled more first-class than coach traffic last June.

Of chief concern to industry leaders is the fact that the historic growth pattern of the trunk airlines has all but disappeared during the past 12 months when coach pulled into its commanding position. In addition, so far this year the industry has been suffering from a severe traffic depression (AW June 17, p. 43).

As revenue passenger miles have dropped, available seat miles have spurted upward despite attempts by the industry to curtail first-class seat miles to offset dwindling demand. Load factors have reacted drastically.

Coach Share of Trunk Traffic

Carrier	June, 1961	June, 1960
National	70.5%	57.2%
TWA	68.5	59.0
United	59.5	48.7*
Eastern	59.4	50.5
Continental	57.6	49.2
Western	57.4	49.3
American	55.0	45.7
Northwest	52.3	60.5
Northeast	52.0	50.1
Delta	48.4	42.9
Braniff	43.8	35.7
Average	57.9	50.0

* Includes United and Capital combined.

Although the industry load factor in June passed the 60 mark for the first time in nine months, the 61.15% load factor achieved was 5.59 points less than that recorded in June, 1960. In the coach category, June's 33% increase in available seat miles far outstripped the 20% increase in revenue passenger miles to drag the month's coach load factor down 6.88 points from the 72.5% level reached the previous June.

First-class available seat miles dropped 3.4% in June, but first-class revenue passenger miles dropped 12.7%. Result was a 5.99 dip in first-class load factors for the trunklines last month.

Only three carriers—Eastern, Northeast and Northwest—registered gains in first-class traffic last month. During the same period, only Northwest showed a decline in coach traffic. All but Northwest and Western increased coach available seat miles, and only Eastern, Delta, Northeast and Northwest increased the available first-class seat miles offered.

Eastern Coach Gain

Eastern recorded the biggest monthly gain in coach traffic in June with a 72% increase over the same period last year. United, which boosted available coach seat miles by 44%, reported a 31% increase in coach traffic during the month.

United, now merged with Capital Airlines, was the only one of the three transcontinental carriers to show an increase in total revenue passenger miles in June. It had a 9.5% gain, compared with losses of 6.4% for American and 4.5% for TWA.

Eastern's total revenue passenger miles rose 45.8%, Delta reported a 10.2% increase and Northeast climbed 13% during the June period. All other carriers showed declines in revenue passenger miles, ranging from five to 11%.

In June, 1961, nine of the 11 trunklines carried more coach traffic than first-class traffic, compared with five of 12 last year. National attributes its high position as a coach operator to the increased capacity of its jet fleet operating in a primarily coach market: New York-Florida. National's coach available seat miles in June rose 44% as the carrier opened new routes to California.

TWA has been expanding its coach services for several years but has conducted a two-edged promotional campaign during this period, aimed at both coach and first-class markets, in order to prevent as much diversion to the lower-fare service as possible.

Eastern's 74% increase in coach available seat miles can be attributed in large part to its low-fare, on-the-hour commuter service between Boston and New York and New York and Washington. In this connection, it is interesting that the two carriers which have launched major new tariff promotional experiments in the past few months are headed by the only two newcomers to top posts in the airline industry—Eastern President Malcolm A. MacIntyre and TWA President Charles C. Tillinghast, Jr.

The CAB can be expected to approve the proposed transcontinental excursion rates since its chairman, Alan S. Boyd, has repeatedly emphasized that he will insist upon the industry exploring new means of generating more traffic and opening new markets.

The Board also has shown no signs of concern over the diversion of first-class traffic to coach services. In its decision to suspend the Braniff tariff calling for higher coach rates, it said that the shift in travel to coach services should not adversely affect the airlines' profit picture and then added that the solution to falling first-class load factors "would seem to lie . . . in an adjustment in the capacity offered in that service."

Civil Aeronautics Board staff members have long held that an expansion of coach facilities will attract a sufficiently large volume of traffic to sustain normal revenue growth. Industry, on the other hand, has argued that coach services should be fitted to the various markets served by the airlines, that some markets are natural coach markets—resort areas, for example—while others are suited primarily to first-class services or business travel.

It is too early to form any conclusions as to the effect the recent growth of coach traffic and the steady decline of first-class traffic will have on gross revenues.

However, the gross operating revenues during the first six months of 1961 climbed 4.76% over the same period last year, while traffic, in the same period declined 1.9%.

Tu-114 Record Claim

Moscow—Soviets claim three new world aircraft weight lifting records for the Tu-114 as the result of a flight from Vnukovo Airport in which the turboprop transport carried a 30,035-kilogram load to an altitude of 41,125 ft. Altitude records are claimed for lifting loads of 20, 25 and 30 tons. The aircraft was piloted by I. Sukhomlin during the 1 hr. 22 min. flight.

United DC-8 Denver Crash Data Sifted by Government Searchers

Preliminary investigation of the Denver crash of a United Air Lines Douglas DC-8 was completed last week and investigators from government agencies and industry are waiting for formal hearings to be announced by the Civil Aeronautics Board early this week.

The Board has received a recommendation that the hearings begin before a month has elapsed from the July 11 incident. The flight recorder was undamaged, the crew survived and more than 100 witnesses saw the accident and were questioned during the preliminary investigation. The pilot, Capt. John Grosso, is reported to have made a normal touchdown close to the runway threshold with all of the 10,010-ft. runway ahead of him.

Investigation of the DC-8 crash which killed 17 people is centered on:

- **DC-8 hydraulic system** and thrust reversers.
- **Techniques** used by the pilot in the landing roll-out.
- **Firefighting** and rescue services available at Denver's Stapleton Airfield.

Early Investigation

The preliminary investigation was started by a panel of six groups of specialists in powerplants, aircraft systems, flight operations, human factors, witness interrogation, and aircraft structures. Later, a seventh group was formed to deal with firefighting and rescue services when a controversy developed over the adequacy and timeliness of the crash crew units at Stapleton. According to one claim, the trucks did not reach the crash scene until 10 min. after the crash, but Denver Mayor Dick Batterton said they were working at the scene within 45 sec. after the plane stopped.

Parts of the wrecked airplane were sent to the United Air Lines maintenance base at San Francisco where they were being analyzed by the powerplants and systems groups. The hydraulic system is receiving special attention because of Grosso's in-flight trouble report and because several other DC-8s recently have been involved in incidents in which hydraulic trouble was present and the aircraft swerved during the landing roll-out. Asymmetric operation of thrust reversers could also cause such a swerve and is being studied as a possible cause of the Denver crash.

The sequence of events as described by witnesses appears to be the following:

The crashed airplane was UAL Flight 859 from Philadelphia to Los Angeles via Chicago, Omaha, and Denver. About 18 min. after takeoff from Omaha with 122 passengers and crew members aboard, Capt. Grosso noted a fluctuation in his hydraulic quantity indication and called Denver Air Route Traffic Control Center for clearance to hold over the Strasburg intersection, a non-compulsory reporting point on the Victor 4 airway between Thurman, Colo. and Denver, while checking out an "abnormal" hydraulic situation. He later reported that hydraulic pressure and quantity were holding and continued to Denver. Denver approach control cleared him for a landing to the east, but Grosso asked for a straight-in approach to the west on runway 26 left.

Wind Negligible

Since the wind was almost negligible and traffic light, clearance was granted. Capt. Grosso warned the passengers that the landing might be a little rough. The landing was made with a quartering tailwind from the right at about seven knots. Investigators calculated that a 10-kt. tailwind would have been acceptable. After rolling about 3,500 ft., a number of tires on eight wheels of the main landing gear blew out and the airplane swerved sharply to the right and off the runway into an area of new construction. Six

Fare Increase

Paris—Air fares within Western Europe will go up by 5% Nov. 1.

New increase was agreed to by carriers at a special meeting held in Paris. No termination date for the higher fare structure was written into the agreement and it is expected that the increases will remain in force until the next general fare conference of IATA, scheduled for the fall of 1962.

New fares will apply to air service between the United Kingdom, Ireland, Scandinavia, France, the Benelux countries, Switzerland, West Germany, Austria, Italy, Yugoslavia, Algeria, Tunisia and Finland.

Spain, Portugal and Greece are not included in the agreement.

K. A. Kristiansen, SAS vice-president and chairman of the Paris meeting, said the higher fare structure was necessary to compensate for an accumulation of new cost factors.

Meanwhile, at an informal IATA meeting in London, North Atlantic carriers decided to take no action on various schemes to lower fares on the North Atlantic.

of the eight tires were found to be blown after the crash.

The airplane plunged across two shallow ditches, losing all three landing gear struts and struck the concrete abutment of a new taxiway and a parked survey truck.

The airplane was skidding sharply to the left and throwing up a cloud of dirt when it hit the panel truck and came to rest on a heading 130 deg. to the right of the runway heading after sliding nearly backward for the last several feet. It did not catch fire immediately and a number of passengers left the airplane safely by using the emergency slide at the front left passenger door. The slide was later consumed by the fire. Most of the survivors escaped through the aft passenger door. Carbon monoxide poisoning and asphyxiation accounted for most of the fatalities aboard the airplane. The fire almost completely destroyed the left wing and the left side of the fuselage. Apparently, none of the passenger seats was collapsed by the various crash impacts. The right inboard engine was the only one which remained attached.

The airplane was a relatively new DC-8, number 146 on the Douglas production line, and was delivered to UAL on June 16, 1961. It had logged an estimated 125 hr. of flying time at the time of the accident.

In a Washington press conference later, Najeeb Halaby, administrator of the Federal Aviation Agency, released a list of 73 DC-8 hydraulic system malfunctions over the past two years. Asked whether the number of malfunctions was excessive, Halaby said, "Judge for yourself." Douglas officials refused to comment, but Douglas engineers were critical in private. They said that if similar lists were released for Boeing and Convair jet transports, the figures for the DC-8 would be found to compare favorably. They said hydraulic systems are always troublesome and few failures need more than routine handling.

Halaby also sent telegrams to DC-8 operators in the United States amending hydraulic emergency procedures in the FAA-approved airplane manual for the DC-8. The amended procedure is intended to conserve pressure in the brake accumulators during free-fall extension of the landing gear after a hydraulic failure. It is the same as the original procedure except that the landing gear control handle is immediately moved to the uplatch-check position after it has been placed in the down position. After about 60 sec., the handle is returned to the down position.

The procedure of letting the landing gear free-fall with the control handle in the uplatch-check position introduces restrictions in the common return circuit of the brake system and the landing gear position control system which reduces a slight brake pressure automatically applied when the landing gear is midway between the retracted position and the extended position. The purpose of this automatic brake pressure is to stop the rotation of the wheels as they are retracted so that passengers will not be alarmed by the sound of an unbalanced wheel. The pressure is ordinarily no more than 200-250 psi. A full actuation can be up to 3,000 psi.

Design of the DC-8 hydraulic system includes an elaborate series of back-up systems and self-healing features intended to prevent hydraulic failures from having catastrophic results. If pressure is lost in the main hydraulic system, check valves prevent fluid from being lost out of the brake circuits.

Pressure is maintained in the brake circuits by a pair of accumulators and can be used for steering as well as stopping. When repeated brake actuations have exhausted the accumulators, the pilot can operate a twist-handle to apply emergency pneumatic braking to both main landing gear trucks at once. The pneumatic braking can be modulated as precisely as the regular system but the anti-skid system is inoperative and the brakes cannot be applied one truck at a time for directional control. If the pilot needs pneumatic brakes, he must rely on throttle-steering for directional control and a foot-thumper warning device indicates wheel skid.

After a loss of system pressure has closed the check valves to isolate the brake system, the two 7.5 in. dia. hydraulic accumulators store about 250 cu. in. of fluid at the system pressure of 3,000 psi. According to the specification for the DC-8, this reserve is supposed to be adequate for four full actuations of both wheel brakes if the brakes are heavily worn. In a new airplane, such as that in the Denver crash, there should have been enough reserve for eight full actuations. With careful use to avoid cycling of the anti-skid system or frequent release of pressure on the brake pedals, the reserve could be made to last almost indefinitely. Investigators reported heavy skid marks on the runway and no failure has yet been found in the brake circuits.

Boyd Warns Reappraisal Needed Of U.S. Bilateral Air Agreements

Civil Aeronautics Board Chairman Alan S. Boyd has warned that international bilateral air transport agreements and the conduct of all parties to the agreements must be reappraised.

Calling for drastic action to prevent wasteful and uneconomical competition, Boyd said that "we cannot afford to be restricted and hampered on the one hand . . . and to be taken over the coals by some foreign carriers, which carriers are taking advantage of the terms of their agreements with us." He spoke to the Commonwealth Club of California in San Francisco.

The speech generally drew praise from U. S. international airlines but was an obvious source of concern to representatives of foreign flag carriers in Washington. In the past, Boyd has been critical of the Bermuda principles and has publicly suggested that the time for a review of these principles has arrived.

Observers here believe the tone of the San Francisco address is similar to the recommendations on international air transportation contained in the Project Horizon report, which is now being circulated through government agencies in Washington for comment.

Boyd admitted in his speech that U. S. carriers are continuing to hold a large percentage of their primary traffic but added "heavy inroads are being made into it, improperly in my view."

He said he does not wish to take a "protectionist" position, but noted that the U. S. is working in a treaty area. "If our carriers must be shackled in this or that respect, then foreign carriers must operate within the same restrictions, otherwise we simply will be slaughtered economically," he said.

It was this sentence that evoked particular interest among Washington observers: "A detailed study of the situation may indicate that the limitations on our carriers' services should be lifted altogether, whereupon I would happily agree to remove restrictions on foreign carriers."

Boyd touched only lightly on the controversial position of the U. S. in wanting capacity restrictions imposed on some foreign flag carriers—such as SAS, KLM or Alitalia—as opposed to its fight against traffic restrictions imposed on the U. S. by such countries as the Philippines, India or Argentina.

He noted that some governments are trying to restrict the number of services offered by U. S. airlines despite the fact that such operations can be justified by Third and Fourth Freedom traffic statistics, then added:

"This is an attempt to predetermine capacity, even though the historical interpretation of the Bermuda language makes it clear that capacity is subject to ex post facto review, not predetermination."

COL. YEVGENI LOGINOV, left, chief of Soviet civil air operations is shown with James M. Landis, special assistant to the President, at the start of U. S.-USSR bilateral air negotiations.

Soviet Bilateral Talks Open on Amicable Note

Washington—Negotiations between the U. S. and the Soviet Union on a bilateral air transport agreement opened last week in an amicable atmosphere suggesting that agreement for reciprocal air services between New York and Moscow will be reached within several weeks.

Through an informal exchange of notes between the two countries, general accord on the basic route structure had been reached prior to the time actual talks began. Essentially, only technical matters concerning the operation remain to be ironed out during the course of negotiations.

The Russians appear eager to begin the new services and evidently will conduct their operations in close conformance with International Air Transport Assn. standards, although they are not members of that group. Headed by Colonel General Yevgeni F. Loginov, chief of the Main Administration of the Civil Air Fleet attached to the Council of Ministers of the USSR, the Soviet delegation includes V. M. Danilychev, S. N. Ermin, K. T. Logvinov, V. S. Gryaznov, A. V. Lebdev, S. S. Pavlov, G. V. Voitsekhovich and A. K. Startsev.

The U. S. delegation is headed by James M. Landis, special assistant to the President. Members of the delegation from the State Department include Edward A. Bolster, vice chairman of the delegation, Carroll E. Cobb and Edward Killham. Civil Aeronautics Board is represented by Chan Gurney and Joseph Watson. Other members are Raymond B. Maloy, Federal Aviation Agency; C. D. Martin, Jr., under secretary of commerce for transportation; and Edward J. Driscoll of the Defense Department.

Russell B. Adams, vice president of Pan American World Airways, is attending as observer.

BOAC Strike Settled; Full Service Restored

London—Strike by British Overseas Aircraft Corp. maintenance workers ended last week after BOAC's London operations were shut down despite intervention by the British Ministry of Labor and the National Joint Council for Air Transport.

Workers returned last Wednesday and the airline expected to be back to full operation over the weekend. Acceptance of the proposal had been recommended by leaders of the Amalgamated Engineering Union and Electrical Trades Union.

Cause of the strike was a BOAC job reorganization plan involving consolidating foreman and inspector jobs into a single supervisory position (AW July 17, p. 51) in the maintenance shops. About 1,000 men were out during the strike.

The wildcat strike resulted in diversion of BOAC bookings to competing airlines, such as Pan American, Trans World, Qantas and Air-India.

United Suggests FAA Blocked Private Study

Washington—United Air Lines has suggested that Federal Aviation Agency tried to block an independent study of air navigation aids in the New York area where a Super Constellation-DC-8 collision resulted in the loss of 128 lives Dec. 16.

Ordered by United in March, the study was conducted by the Armour Research Foundation of the Illinois Institute of Technology. It entailed Armour technicians' visiting Colts Neck VOR facility, one of several stations that the pilot of the United DC-8 may have been using to fix his position when the jet collided with a Trans World Airlines Super Constellation.

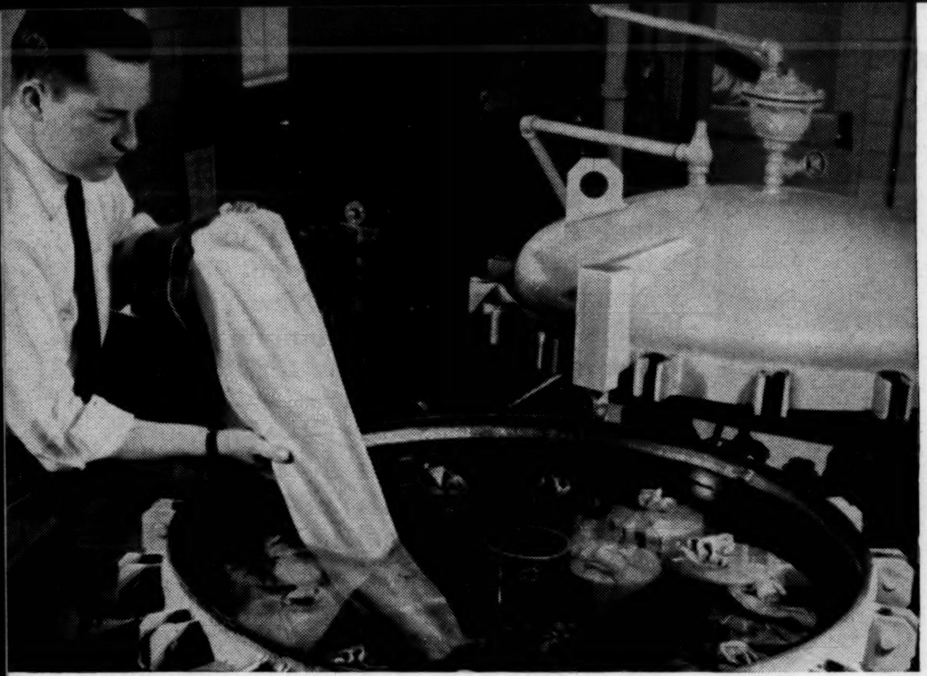
In a July 7 letter to James T. Pyle, FAA deputy administrator, Charles F. McErlean, United's senior vice president-law, said:

". . . The fact that you stepped in and halted the visit to Colts Neck after arrangements had been made by Civil Aeronautics Board representatives indicated to us that apparently your agency was not interested in permitting such an investigation." According to McErlean, Pyle told Armour that he would not let anyone inspect FAA facilities if it appeared their inspection would form the basis "for any liability on the part of the FAA or the government."

Taking issue with United, an FAA spokesman told Aviation Week that "as of last week" the agency had offered to make all necessary arrangements if Armour still wanted to study the Colts Neck VOR facility. However, information received by FAA indicated that United had lost interest in this aspect of the study and that CAB had been so informed, he said.

The exchange between United and FAA came less than two weeks before the second stage of the public hearing on the cause of the New York accident was to open here. As the inquiry resumed last week, more than 20 witnesses were scheduled to testify. When the first stage of the hearing closed in New York last January (AW Jan. 16, p. 38 and Jan. 23, p. 49), CAB had heard the testimony of 77 witnesses during eight days.

It appeared certain on the eve of the reopened hearing that flight recorder tape data from other jets flying through the area just prior to the collision still were not ready for the record. About 30 of the tapes were prepared by CAB, included in the record as an official exhibit and then withdrawn at the last moment after several interested parties questioned the data's accuracy and relevance.



LOCKHEED JETSTAR—FIRST U. S. CORPORATE TURBOJET

Left: Shell engineer tests filter-separator at the AeroShell Turbine Fuel Equipment Laboratory—first in the U. S. **Right:** New Lockheed JetStar refuels. Shell sold over one billion gallons of aviation fuel last year.

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4. First turbine fuel equipment lab assures maximum cleanliness. Shell set up the first U.S. laboratory in the industry to study turbine fuel cleanliness. Its purpose: to assure Shell's ability to deliver uniformly clean fuel to your airplane.

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Whatever plane you fly, wherever you fly it, Shell's experience in aircraft fuels and lubricants assures you of top performance.

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Japan Air Lines Receives First Convair 880-M

First Convair 880-M transport of a five-plane order has been delivered to Japan Air Lines by General Dynamics' Western Group. Plane has been named Sakura or Cherry Blossom by the airline. Second and third 880-Ms will be delivered to JAL before the end of the month. Final two transports will join the carrier's fleet in May, 1962. Interior of the 90-passenger plane was decorated in a Japanese motif. The General Electric CJ805-3B-powered aircraft initially will be used by JAL on a Tokyo/Hong Kong/Bangkok, Singapore route.

Northwest Pegs Profit to Cost Controls

By Glenn Garrison

New York—Tight cost controls helped Northwest Airlines show a net profit of $1¼ million for the first six months of this year, compared with a loss of $224,000 for the same period of last year, despite a drop in gross operating revenues because of strikes which curtailed operations during part of 1961.

President Donald W. Nyrop told members of the New York Society of Security Analysts here that Northwest's operating revenues for the 1961 period totaled $45,973,000, with operating expenses of $42,473,000, for an operating profit of $3½ million. Comparable figures for the first half of 1960 were $61,973,000 operating revenues, $61,419,000 operating expenses, $554,000 operating profit.

The airline maintains "a series of real tough budget controls," Nyrop said, with monthly budget reviews. Northwest's total operating costs per available ton mile, according to figures presented by Nyrop to the analysts, for several years have been lowest among five trunk carriers in domestic service—American, TWA, United, Capital and Delta. A similar comparison of 12-month moving averages shows Northwest with the lowest available ton mile costs of all U. S. and foreign flag carriers in international service.

At the end of 1960, according to Nyrop's figures, Northwest's domestic ton mile cost was about 16.5 cents. Highest in the scale was Capital Airlines at about 34 cents. These statistics indicate how Capital got into trouble, Nyrop told the analysts.

Continental Airlines was not included in the comparisons, and Nyrop acknowledged that Continental was "doing a fine job in cost control" and probably was showing results as good as Northwest or better.

As a result of its basically long-haul route structure, Northwest has one of the highest average dollar ticket sales in the business, he added. The airline's route to Miami helped to reduce a seasonal imbalance. Northwest did well on the Miami route in the 1959-60 season, but was stymied by strikes in the last Florida season. Another favorable factor is less competition on international routes than that faced by transatlantic operators.

Northwest serves some small cities on its domestic routes, and its position in serving them differs from that of some other trunklines, Nyrop said. Northwest has not asked to discontinue such services, because it feels they produce enough long-haul traffic to make the service worth while, he added.

In addition to labor troubles, Northwest was handicapped in 1960 by the Electra accident and resultant speed reductions. Direct operating costs of the turboprop increased 20%, Nyrop said. There was also the problem of public non-acceptance. But the airplanes were back to normal speed Apr. 1 on Northwest's routes, load factors are good now, and there is little or no resistance on the part of the public. Direct operating costs now average about $1.25 per mile, comparable with the DC-6, and further reduction is expected in the future.

Direct operating costs of the airline's DC-8s are $2.48 per mile, Nyrop said. This is high, and reflects the strike period when the airplanes were on the ground, earning no money but piling up depreciation costs. Scheduled utilization of the DC-8s next month will be 10 hr. 15 min. daily average; Boeing 720B utilization will be about 10 hr. 20 min. The Electras' utilization now is slightly less than 9 hr. and the DC-6 utilization is slightly less than 8 hr.

Regarding the 720B, Nyrop said he expects fuel saving of $750,000 next year, with New York-West Coast fuel consumption 8,000 lb. less with the 720B than with a straight jet.

Asked of the effects on Northwest of the United-Capital merger, Nyrop said United is a tough competitor and "personally, I liked Capital just the way they were." But Northwest should compete adequately with United, he said. On the Seattle-New York route, Northwest carried 65% of the passengers in 1957, 1958 and 1959 where it competed with United, Nyrop said.

Northwest's Electras are not intended to compete with United's Sud Caravelles, Nyrop said. The Electra will serve short-haul markets where the Caravelle could not make money. Where the Caravelle and 720B compete, "the 720B will outcarry the Caravelle every day of the week."

Regarding the future traffic growth of the industry, Nyrop predicted a rate of 8-12%, varying from year to year. Increased living standard will provide more residual income for travel, he said. Northwest's own growth rate was about 14% a year from 1954 through 1959, which he doubts will be repeated; about 10% in the next few years is more likely.

Nyrop said he expects further mergers in the industry within the next four or five years. However, Northwest at present has no merger or acquisition plan under consideration, he said.

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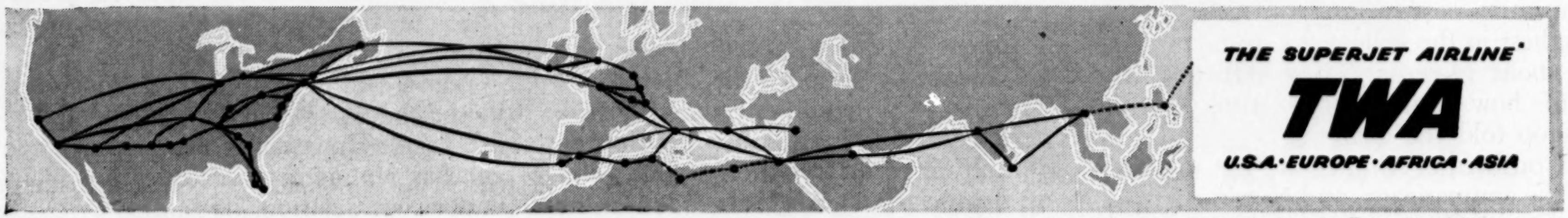

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Airline Traffic—May, 1961

	Revenue Passengers	Revenue Passenger Miles (000)	Passenger Load Factor %	U. S. Mail Ton-Miles	Express Ton-Miles	Freight Ton-Miles	Total Revenue Ton-Miles	Over-all Load Factor %
DOMESTIC TRUNKS								
American	657,165	497,292	61.0	2,270,203	1,015,466	10,578,108	61,520,373	54.5
Braniff	191,975	88,670	56.3	414,817	162,455	921,266	10,000,218	45.6
Capital	279,483	114,314	48.1	612,203	300,890	491,468	12,354,095	44.2
Continental	111,446	71,014	44.5	255,877	115,688	678,137	7,848,745	37.5
Delta	310,553	173,097	61.6	608,813	325,208	1,511,094	19,079,134	52.5
Eastern	657,467	320,267	48.2	1,378,954	536,685	2,384,589	35,066,234	38.8
National	85,449	46,991	46.0	192,678	35,819	584,676	5,340,804	37.3
Northeast	142,851	61,874	48.8	182,743	55,128	352,955	6,509,490	41.6
Northwest	140,550	95,604	54.9	552,536	196,824	1,011,470	10,909,954	48.5
Trans World	399,266	350,687	55.8	1,474,103	657,985	4,571,344	40,329,339	45.1
United	696,352	501,963	56.3	3,578,560	1,040,028	8,239,016	60,959,330	49.5
Western	107,745	61,479	51.4	270,890	97,793	369,219	6,633,728	42.3
INTERNATIONAL								
American	5,197	5,453	38.0	6,054	884	287,151	859,858	36.8
Braniff	7,251	11,738	44.8	70,022	....	152,389	1,463,541	38.8
Caribbean Atlantic	32,528	2,232	63.3	2,628	....	9,478	219,739	63.0
Delta	1,221	1,711	34.9	836	....	8,941	191,746	33.2
Eastern	36,736	54,000	52.3	193,919	....	496,456	5,754,333	49.1
Mackey	15,116	2,480	51.1	....	190	8,688	252,053	50.6
Northwest	15,613	31,100	50.6	1,498,038	4,350	719,827	5,559,500	59.2
Pan American								
Alaska	5,376	5,557	50.6	38,023	3,316	169,952	795,948	48.7
Atlantic	154,471	211,947	54.3	2,649,333	....	4,232,303	28,822,186	47.9
Latin America	82,964	112,471	57.7	484,508	....	3,858,022	15,797,430	58.0
Pacific	41,388	169,554	67.8	3,784,728	15,068	2,846,034	24,140,062	58.0
Panagra	9,246	16,375	52.2	87,357	....	564,627	2,420,138	54.0
South Pacific	136	373	34.0	292	....	1,974	40,627	29.6
Trans Caribbean	9,411	14,306	70.9	....	....	329,657	1,527,205	72.5
Trans World	25,520	78,345	44.4	1,553,114	....	1,725,506	11,372,139	43.5
United	11,888	29,512	53.2	307,688	7,165	142,399	3,473,141	46.7
Western	3,672	5,709	40.6	12,144	....	36,665	636,063	36.1
LOCAL SERVICE								
Allegheny	72,672	15,113	42.8	23,693	42,003	72,244	1,580,886	46.2
Bonanza	25,783	6,405	44.2	7,988	3,080	12,544	638,403	45.2
Central	19,043	3,584	30.6	14,787	8,645	21,788	388,828	29.8
Frontier	28,503	7,396	37.5	33,138	10,927	65,089	818,024	41.6
Lake Central	38,234	6,261	33.7	11,242	22,598	14,319	646,594	34.1
Mohawk	62,501	12,976	44.5	24,761	25,001	31,070	1,319,722	42.3
North Central	82,629	15,002	42.1	46,676	46,390	62,984	1,595,881	43.2
Ozark	52,073	8,946	43.3	21,949	27,390	37,012	940,413	47.5
Pacific	40,926	9,758	49.7	16,003	4,356	8,882	959,490	49.9
Piedmont	45,385	9,661	45.9	15,246	13,992	24,481	980,039	47.1
Southern	33,378	6,085	33.8	24,763	13,447	22,322	643,536	35.6
Trans-Texas	27,033	6,236	37.3	22,386	11,380	43,804	675,197	38.6
West Coast	31,055	7,523	40.5	16,500	5,558	24,942	765,410	41.2
HAWAIIAN LINES								
Aloha	24,708	3,622	61.3	3,333	....	5,344	298,827	50.4
Hawaiian	34,195	5,107	59.5	5,797	....	137,393	552,945	59.1
CARGO LINES								
Aerovias Sud Americana	....	....	......	....	....	254,485	254,485	67.3
Flying Tiger	4,273	18,824	69.8	16,438	25,425	9,721,709	11,656,027	76.8
Riddle[1]	....	....	......	....	....	....	....	....
Seaboard World	3,325	13,236	100.0	1,092,163	....	3,670,949	6,095,491	68.6
Slick	1,479	10,166	96.5	....	....	1,534,975	2,551,521	85.2
HELICOPTER LINES								
Chicago Helicopter	22,174	388	45.1	1,263	....	163	38,257	37.6
Los Angeles Airways	3,810	141	53.0	5,874	2,480	....	21,793	60.6
New York Airways	12,158	223	51.0	1,484	838	524	24,079	48.8
ALASKA LINES								
Alaska Airlines	9,977	9,275	59.0	66,609	2,265	397,485	1,422,040	66.4
Alaska Coastal	5,799	593	60.8	4,473	....	6,066	70,638	65.1
Cordova	2,099	330	54.5	4,397	....	32,833	71,175	59.5
Ellis	4,510	308	52.3	1,923	....	2,961	36,377	61.8
Kodiak	1,213	70	40.9	440	....	1,075	8,596	36.4
Northern Consolidated	3,262	1,094	39.4	54,418	....	74,748	247,083	56.8
Pacific Northern	11,750	10,711	51.1	154,057	12,036	438,241	1,765,835	65.1
Reeve Aleutian	1,845	1,429	43.3	65,866	....	127,651	350,157	60.0
Western Alaska	419	25	81.0	783	....	378	3,530	73.0
Wien Alaska	3,824	1,109	46.6	57,315	....	125,681	295,922	51.8
Avalon	7,348	349	43.9	824	....	526	34,503	45.7

[1] Not available.

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

Pioneers in mission management

supersonic fighters

MARK II, III, IV—pioneered as progressive projects by the Flight Control Laboratory of the USAF Aeronautical Systems Division. Each objective, a functional application of the man/machine concept. Each a wholly integrated control and display system, designed around the capabilities of man and his machine to achieve the ultimate in mission management. And, today, on the threshold of space exploration, the completed ASD/Lear Mark IV project has provided experience and technological know-how to the Air Force . . . a comprehensive systems capability to "design in" all the control/display requirements for mission management to take man . . .

to the moon
and on beyond

supersonic bombers

space exploration

LEAR INSTRUMENT DIVISION • 110 IONIA AVENUE N.W. • GRAND RAPIDS, MICHIGAN

SHORTLINES

▶ **Civil Aeronautics Board** Examiner Curtis C. Henderson has recommended that Ozark Air Lines' certificate be amended to allow one-stop service between Chicago and St. Louis via either Springfield or Peoria, Ill.

▶ **Continental Airlines** will expand the capacity of its jet maintenance base at Los Angeles International Airport to accommodate the airline's four turbofan Boeing 720B transports, scheduled for delivery next spring. The $1-million expansion will house three jet aircraft simultaneously when completed in March.

▶ **Dr. James L. Goddard** will serve as Federal Aviation Agency's civil air surgeon for another two years, heading the Aviation Medicine Service.

▶ **Eastern Air Lines** will double its no-reservation air-shuttle flights between Boston and New York after Aug. 1. Eastern will fly 16 flights daily in each direction weekdays between 7 a.m. and 10 p.m., compared with eight flights now scheduled.

▶ **Frontier Airlines,** one of two local service carriers filing formal protests against Civil Aeronautics Board's class subsidy rate, has withdrawn its objections and will be paid at the subsidy rate for service retroactive to last Jan. 1. Central Airlines is still protesting the class rate.

▶ **Iberia Air Lines** will receive one Caravelle turbojet aircraft next January, one in March and two in April, 1962. The aircraft will be used on Iberia's European and African routes.

▶ **International Air Transport Assn.** has adopted a standard air-sea traffic agreement, allowing passengers on member airlines traveling between North America and the Orient or Australasia to fly one way and go by ship the other. Under the agreement, IATA members can designate the shipping company within the Transpacific Passenger Conference with which they will exchange passengers.

▶ **Military Air Transport Service** has awarded $2.5 million in contracts for transportation of overseas passengers and cargo during June, July and August to 11 carriers.

▶ **Voit Gilmore** has been named director of the new United States Travel Service. He was associated with Pan American World Airways 1940-47, and he currently operates travel facilities in the Southern Pines, N. C. area.

AIRLINE OBSERVER

▶ **Appointment of James M. Landis, special assistant to the President, to head the delegation negotiating with the Russians on a bilateral air transport agreement is prompting the industry to ask whether the White House intends to take over all future bilateral negotiations, historically a function of the State Department.**

▶ Watch for a move by Scandinavian Airlines System to cut its 14,000 payroll by as many as 2,000 employes in its new management drive for greater operating efficiency. Reduction will be confined principally to the main maintenance and operations base area, where complexity and duplication exist because of the consortium requirement that Denmark, Sweden and Norway each participate in SAS activities. Inventory controls will be tightened to eliminate excess spare part stores, among other changes.

▶ **Ghana Airways is having serious financial troubles. One month after the airline started its trans-African service, flight frequency was cut from one a week to one flight every two weeks. Ghanaian government reportedly was forced to dip into naval academy funds to help the carrier meet one month's payroll. Financial difficulties stem chiefly from the fledgling carrier's ambitious equipment and route programs (AW Dec. 12, p. 38). However, the Ghanaian government apparently is still willing to underwrite substantial losses in order to make Ghana Airways the dominant carrier of independent Africa.**

▶ Federal Aviation Agency has recommended that Congress make assault, robbery, maiming and other acts of violence federal crimes if they are committed on airline aircraft in interstate commerce. Civil suits filed by the Administrator now are FAA's prime weapon against such offenses. Two court actions, each asking a $1,000 penalty, have been filed against individuals described as "drunken fools" by Administrator N. E. Halaby.

▶ **Revival of sightseeing flights as a means of utilizing idle aircraft is spreading. American Airlines is conducting Lockheed Electra II half-hour flights in a number of cities on its system over weekends. Braniff plans to offer Boeing 707 sightseeing flights in Dallas. Mohawk Airlines is operating children's birthday party flights with increasing success. The local carrier charters a DC-3 for 30 min. at a $65 charge, which includes birthday cake and favors. American estimates that 30% of its sightseeing flight customers are first riders.**

▶ Northwest Airlines is negotiating with Boeing Co. for three Boeing 720B turbofan transports in addition to the six it now has on order. Under the plan, Northwest will purchase one additional aircraft and lease two from Boeing.

▶ **U. S. has granted loans totaling $23.3 million through the Development Loan Fund to the government of Ethiopia for aviation projects. Of this total, $20.2 million will be used to build or improve four major and 22 minor airports, and $3.1 million will be used for procurement of maintenance and overhaul equipment and for spare parts for Ethiopian Airlines.**

▶ Federal Aviation Agency has purchased an automatic telecommunications system from North American Philips Co. for installation at Anchorage, Alaska. Flight plans, weather information and air traffic control reports will be fed into the new system from 65 FAA and other stations and will be switched automatically to the proper receiving station. The system will replace the present process of accepting a punched tape and manually placing it into the proper circuit.

▶ **First complete drafts of reports prepared by Project Horizon and Project Beacon task forces have been distributed to the Defense Department, Bureau of Budget, Civil Aeronautics Board and other agencies for comment. They are to be returned to the task forces this week, when they will be sent to the White House. Civil Aeronautics Board reaction to the drafts has been reported as highly favorable.**

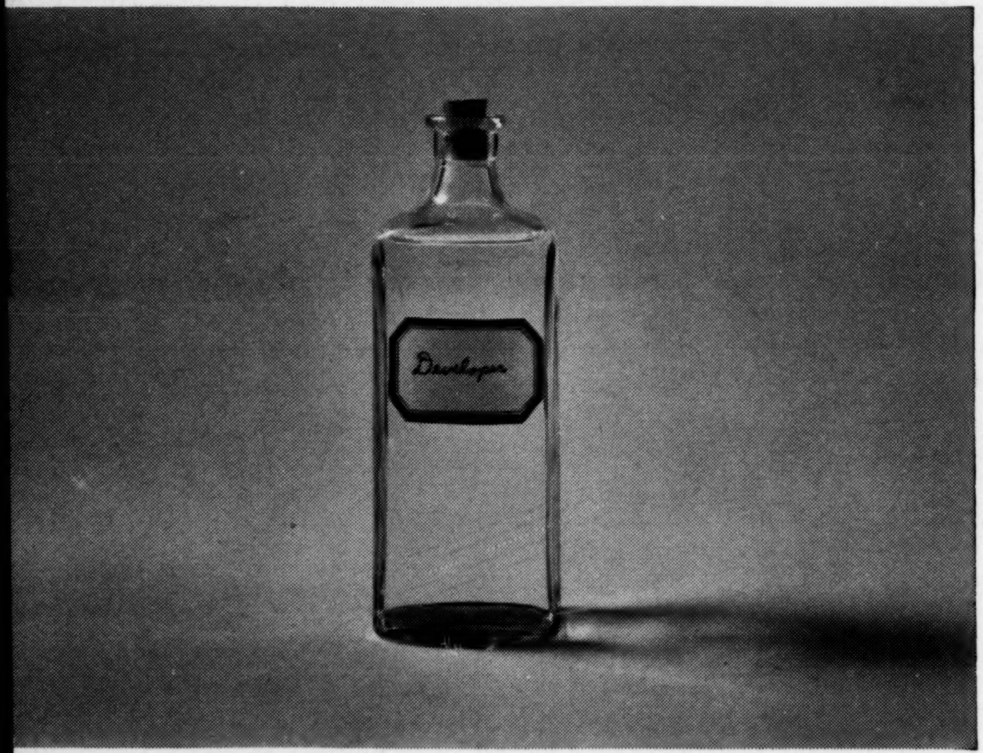
Kodak
TRADEMARK

Kodak's method of recording

If photography had been invented during the past five years instead of way back early in the 19th century, people wouldn't be working so hard and spending so much money looking for other ways to accomplish what photography can already accomplish.

The antiquity of photography illogically blinds some to its virtues. To the extent (slight, it must be admitted) that this delays its application to practical problems that it can solve today, the blindness is unfortunate though understandable.*

*We ourselves are not blind. We know that there are many ways of producing images. We are investigating a lot of them.

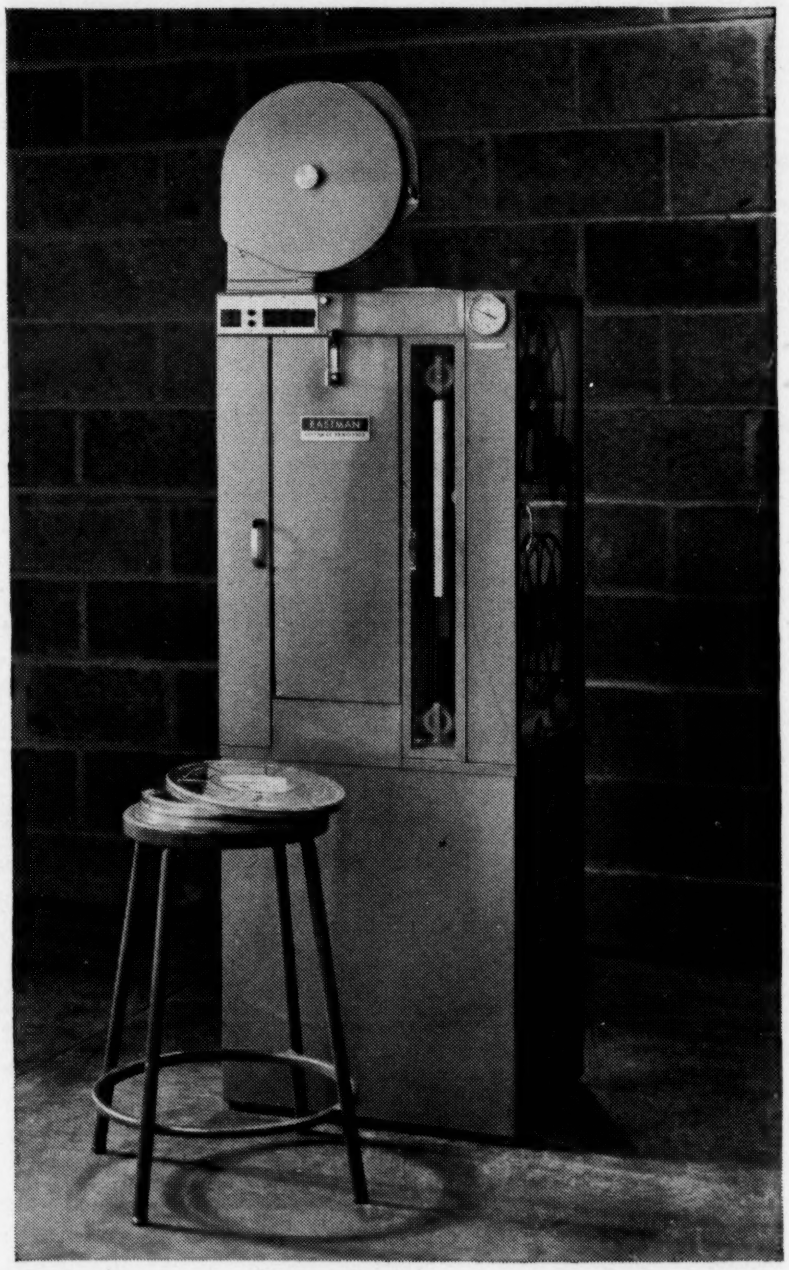


VIRTUE No. 1 is simplicity. Here is a picture of the basic amplifier used in photography.

This amplifier can provide a gain of 10^9. There is a genie in the bottle. We know him very well.

Some, whose impressions were formed while working out for the merit badge in photography, still think of summoning up the genie by retiring to a little darkroom and pouring him out of his bottle into a white enameled tray. Therefore, they think of him as always all wet, and this thought discourages them.

We hereby advise them that we can put the genie to work for them by any of a growing number of techniques in which the wetness hardly shows. It's an engineering problem, not a scientific problem. We have a goodly number of engineers who are very competent in the field and are available under suitable arrangements.

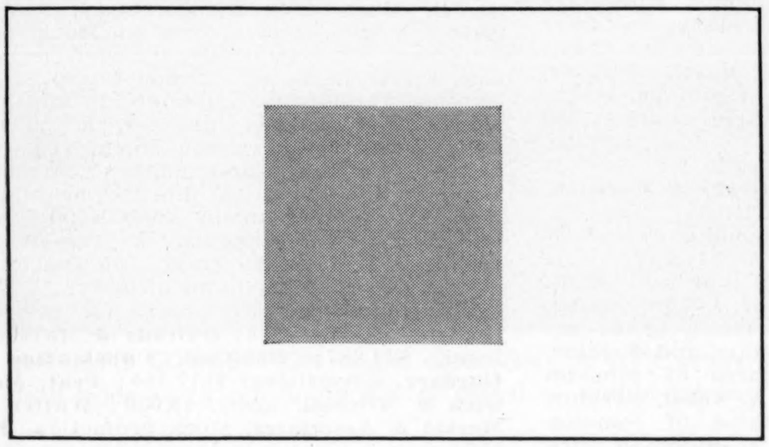


This newly announced Eastman Viscomat Processor is a sample of their past work. It does 36 feet per minute. This happens to be the rate at which film runs through a projector. The film spends about one minute in the processor. It emerges processed to standard commercial quality, ready to project. The machine can be stopped for seconds or days and restarted without loss of quality. We are very touchy about processing quality, since we are also film-makers by trade and feel a need to keep our faith in photography.

was invented too soon

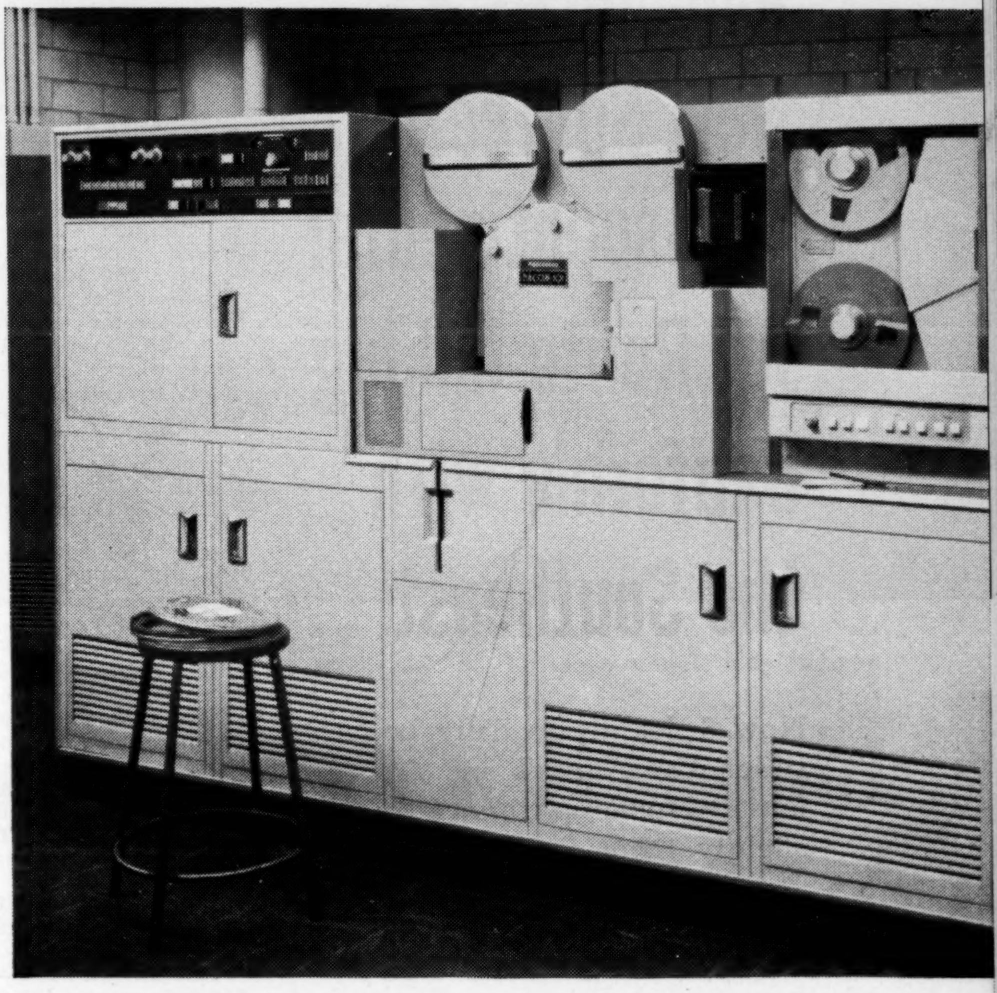
VIRTUE No. 2 is information-packing density. Nothing else is even close to photography in this respect.

Look at this one-inch square. As you will see, if



you whip out your pocket magnifier, it is composed of the familiar halftone dots. You see about 10,000 dots. Into the same area, photography could have put the same number of *pages* of the Encyclopaedia Brittanica and recovered every character of them!

We can trade off a little of this extreme information density for more light-sensitivity and pack only 10^8 bits of information into a square inch of film. This figure is still hard for non-photographic techniques of data-recording to match. Furthermore, it is not just a goal we are working toward. It is available in a film we have actually manufactured by the thousands of feet.



This Recordak Dacom Recorder permits a computer to unburden itself directly to microfilm. Microfilm is the proper medium for massive detail. Paper need come in, if at all, only at the end of the line for summaries and conclusions. Any part of the supporting data is available for visual scrutiny, if desired. Modifications permit plotting on microfilm from taped data, 2500 points per second, very close, very linear, very repeatable, very little film from very much tape.

PHOTOGRAPHY

OPTICS

ELECTRONICS

MECHANISMS

INFRARED

To ask questions about how Kodak can create useful results from the information-packing density, the incomparable sensitivity, and the essential simplicity of photography; or for a general book that inventories the interconnected capabilities of the Kodak *force in being* in our five fields, write or phone Advanced Planning Department,

KODAK
A FORCE IN BEING

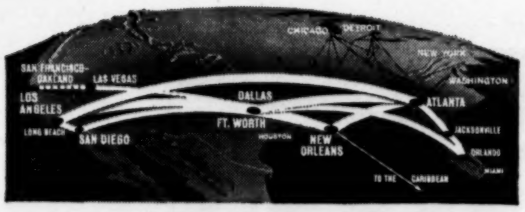
EASTMAN KODAK COMPANY, *Apparatus and Optical Division, Rochester 4, N. Y.*

DELTA

announces a New Southern Transcontinental Jet Route linking California with the Southeast

Now 6 Jet flights daily between Los Angeles and Atlanta! Non-stop service in slightly more than 4 hours . . . other jets link Los Angeles and Atlanta by way of Dallas/Ft. Worth and New Orleans. Plus direct service between San Diego, Las Vegas and Dallas/Ft. Worth, New Orleans, and Florida. And later in the summer Delta jet service to San Francisco.

DELTA AIR LINES



Delta's new routes to the West Coast

DELTA

A New Southern Transcontinental Route

Alaskan Carriers List Officers', Directors' 1960 Remuneration

Washington—Following is a list of airline officers' salaries, bonuses and indirect compensation, expenses, and stockholdings for the year ending Dec. 31, 1960, as filed with the CAB.

Alaska Coastal Airlines—S. B. Simmons, co-manager, $19,824 salary, no stock, $1,731 expenses; **O. F. Benecke,** co-manager, $19,039 salary, no stock, $1,110 expenses.

Following firms were paid for services rendered during 1960: **Theodore I. Seamon,** legal retainer fee and expenses, $12,481.

Cordova Airlines—M. K. Smith, president and director, $20,000 salary, 18,050 shares of common stock, $6,796 expenses; **R. R. Berer,** vice president and director, $200 salary, 200 shares of common stock, $19 expenses; **G. Dillard,** secretary, treasurer and director (resigned Feb. 28, 1960), $2,666 salary, no stock; **A. L. Martin,** director, $150 salary, 2,500 shares of common stock; **A. C. Swalling,** director, $150 salary, 2,500 shares of common stock.

Following firms were paid for services rendered during 1960: **O'Grady & Marshall,** legal, $7,563 (includes 1959).

Ellis Air Lines—C. A. Bodding, vice president-operations and director, $16,215 salary, 8,612 common stock, $262 expenses; **R. E. Ellis,** president and director, $16,800 salary, 21,296 shares of common stock, $2,407 expenses; **N. T. Gerde,** secretary and director, $16,110 salary, 4,833 shares of common stock, $358 expenses; **W. A. Nebel,** director, $12,900 salary, 2,688 shares of common stock, $281 expenses; **J. L. Sherman,** vice president-maintenance and director, $13,800 salary, 8,075 shares of common stock, $629 expenses; **K. J. Vanderweele,** director, $10,500 salary, 2,029 shares of common stock, $222 expenses; **J. Diamond,** director, $14,415 salary, 775 shares of common stock, $114 expenses.

Following firm was paid for services rendered during 1960: **Stump & Bailey,** legal, $6,120.

Kodiak Airways—R. L. Hall, president, $18,000 salary, 29,998 shares of common stock, 35,000 shares held jointly with wife, $15,000 debt securities, (unsecured note payable).

Kodiak paid no firms more than $5,000 during 1960.

Northern Consolidated Airlines—R. I. Petersen, president and general manager, $25,000 salary, 219,070½ shares of common stock, $4,126 expenses, $1,100 bonus and indirect compensation, $2,300 debt securities; **S. B. Fitzhugh,** vice president and treasurer, $17,333 salary, 17,503 shares of common stock, $2,534 expenses, $1,100 bonus and indirect compensation, $1,600 debt securities; **J. A. Walatka,** director, $15,000 salary, 60,025½ shares of common stock, $1,494 expenses, $1,100 bonus and indirect compensation, $3,200 debt securities; **C. J. Johnston,** director, no salary, 1,500 shares of common stock, $61 expenses, $500 bonus and indirect compensation; **R. C. Miller,** chairman, no salary, 44,586½ shares of common stock, $1,500 bonus and indirect compensation; **E. Olson,** director, no salary, 1,200 shares of common stock, $100 bonus and indirect compensation; **D. G. Rupe,** director, no salary, five shares common stock, 61,857 shares of common stock in the name of others, $100 bonus and indirect compensation; **V. R. Davis,** secretary, $12,000 salary, 593½ shares of common stock, $583 expenses, $550 bonus and indirect compensation; **M. A. Petersen,** assistant secretary, $4,800 salary, 54,000 shares of common stock; **G. R. Unwin,** assistant treasurer, $10,925 salary, 7,575 shares of common stock, $331 expenses, $3,200 debt securities.

Following firms were paid for services rendered during 1960: **Price Waterhouse & Co.,** audit fees, $6,530; **Theodore I. Seamon,** legal services, $15,000.

Pacific Northern Air Lines—A. G. Woodley, president and director, $35,000 salary, 226,378 shares of common stock, $4,075 expenses, $100 bonus and indirect compensation; **J. A. Cunningham,** vice president and director, $19,436 salary, 1,500 shares of common stock, $178 expenses, $100 bonus and indirect compensation; **H. A. Olsen,** vice president, $17,103 salary, 5,065 shares of common stock, $982 expenses; **J. H. Foster,** vice president, $17,103 salary, 1,000 shares of common stock, $474 expenses; **F. Aubuchon,** vice president, $14,135 salary, 4,100 shares of common stock, $13 expenses; **T. D. Stuart,** vice president, $13,200 salary, 1,700 shares of common stock, $366 expenses; **C. W. Nelson,** secretary-treasurer and director, $15,548 salary, 500 shares of common stock, $196 expenses, $100 bonus and indirect compensation; **N. E. Diamond,** assistant secretary, $9,894 salary, 27,713 shares of common stock, $115 expenses; **D. B. Hart,** assistant secretary, $11,428 salary, 2,520 shares of common stock, $138 expenses; **G. P. O'Grady,** director, no salary, 3,001 shares of common stock, $3,887 expenses, $100 bonus and indirect compensation; **R. A. Rowen,** director, no salary, 14,500 shares of common stock, $202 expenses, $100 bonus and indirect compensation; **N. B. Kirkpatrick,** director, no salary, 3,051 shares of common stock, $100 bonus and indirect compensation; **P. Perselt,** director, no salary, no stock, 100 shares of common stock in the name of others.

Following firms were paid for services rendered during 1960: **O'Grady & Marshall,** legal, $27,887; **Botsford, Constantine & Gardner,** advertising, $117,394; **Peat, Marwick & Mitchell,** audit, $8,000; **Walter F. Merkel & Associates,** stock promotion, $9,657.

Reeve Aleutian Airways—R. C. Reeve, president, $19,500 salary, 264 shares of common stock, $5,865 expenses; **R. L. Hanson,** vice president, $12,000 salary, 50 shares of common stock, $76 expenses, $10,000 bonus and indirect compensation; **M. Rutledge,** secretary-comptroller, $12,000 salary, no stock, $22 expenses, $3,000 bonus and indirect compensation; **J. Reeve,** treasurer, $13,000 salary, 264 shares of common stock, $165 expenses.

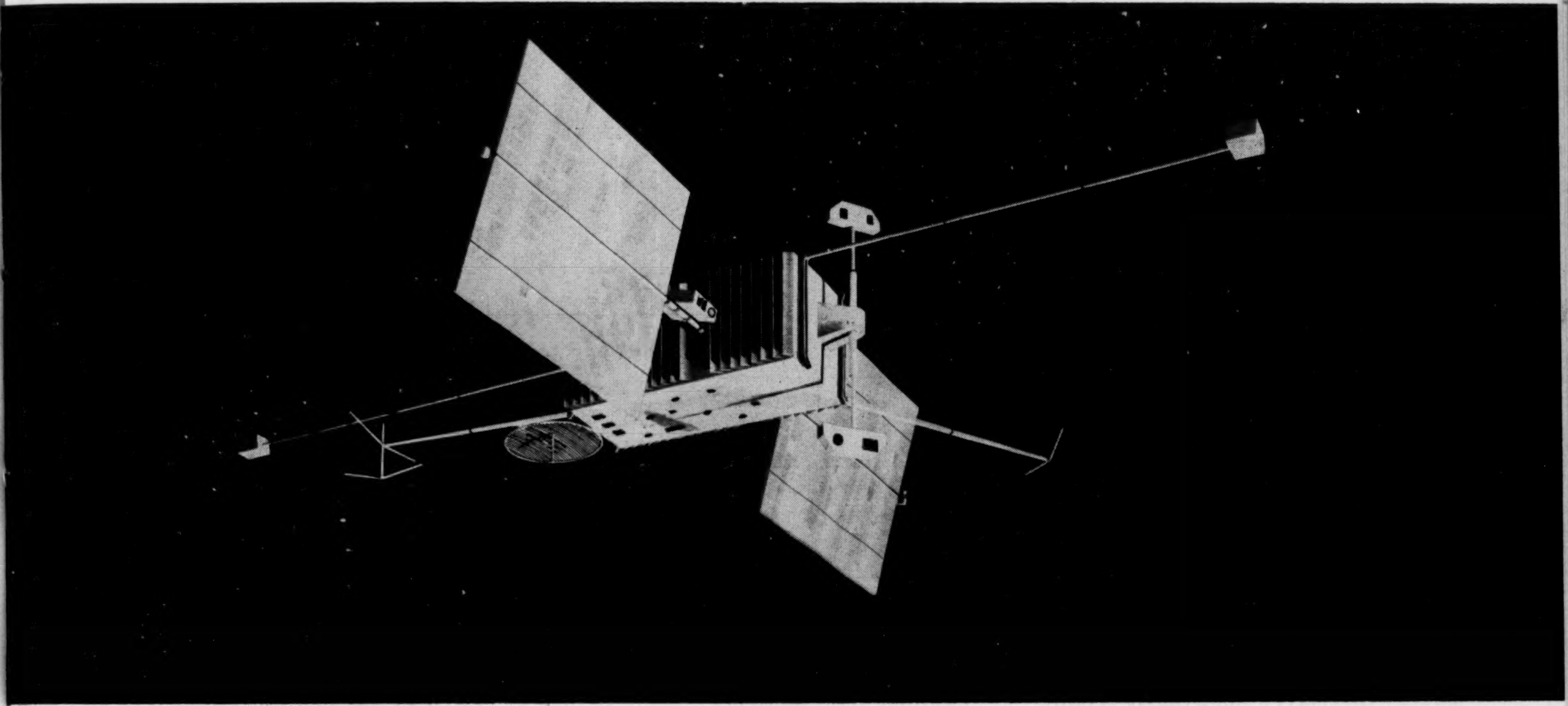
Following firm was paid for services rendered during 1960: **Scott, McMahon & Co.,** certified public accountants, $7,474.

Western Alaska Airlines—A. W. Ball, president, $17,500 salary, 238 shares of common stock, $1,000 debt securities; **M. Moran,** vice president, $14,500 salary, 238 shares of common stock, **C. Wren,** secretary-treasurer, no salary, 100¾ shares of common stock.

Following firm was paid for services rendered during 1960: **Lear & Scoutt,** legal, $8,177.

Wien Alaska Airlines—S. Wien, president and chairman, $23,000 salary, 5,532 shares of common stock, $169 expenses; **G. B. Rayburn,** executive vice president, $21,802 salary, 1,140 shares of common stock, $1,673 expenses; **F. Wien,** vice president-operations, $19,550 salary, 1,119 shares of common stock, $770 expenses; **A. E. Hagberg,** vice president-traffic, $19,478 salary, 126 shares of common stock, $2,849 expenses; **N. Wien,** vice president-public relations, $18,975 salary, 1,126 shares of common stock, $2,554 expenses; **R. M. King,** secretary, $20,100 salary (for services other than secretary), 101 shares of common stock, **R. B. Webb,** assistant secretary, no salary, 52 shares of common stock; **M. Barnes,** assistant secretary, $6,471 salary, no stock; **M. Whitney,** assistant secretary, no salary, 25 shares of common stock, **B. Staheli,** assistant secretary, no salary, no stock; **C. J. Clasby,** director, no salary, 104 shares of common stock; **A. Polet,** assistant secretary and director, no salary, 184 shares of common stock; **B. Balchen,** director (upon Civil Aeronautics Board approval), no salary, no stock.

Following firms were paid for services rendered during 1960: **Collins & Clasby,** legal, $6,104; Air Transport Assn. airline industry liaison, $5,018; **Theodore I. Seamon,** legal, $12,755; **R. T. Lamson,** aviation consultant, $5,965.



ARTIST'S CONCEPTION of the observatory in orbit shows the two 15-lb. boom-mounted experiment packages and the louvered vertical sides which can be opened or closed to control internal temperature. Solar panels on either side of the space vehicle face the sun.

'Economy' Space Observatories Designed

By Russell Hawkes

Los Angeles—Orbiting Geophysical Observatory (OGO), being designed for NASA by Space Technology Laboratories especially to study earth-centered phenomena in space, follows current trends toward standardization and multiple purpose design.

Though NASA has ordered only four of the spacecraft to be built, STL officials are confident there will be reorders to take advantage of the low costs made possible by these design practices. The four spacecraft ordered include one non-flying prototype and three flight versions. One of the flyable spacecraft will be dubbed EGO (Elliptical Orbit Geophysical Observatory), one will be called POGO (Polar Orbit Geophysical Observatory), and one will be held in reserve in case one of the other two is unsuccessfully launched. If both of the first two are successful, the back-up spacecraft probably will be used as a second POGO.

First of the spacecraft to be launched will be EGO, tentatively scheduled for the spring of 1963. It will be launched from Cape Canaveral by an Atlas-Agena B launch vehicle into a 31-deg. inclined orbit. The orbit is to be highly eccentric with a perigee of 150 mi. and an apogee of 60,000 mi.

POGO launch is tentatively scheduled for the fall of 1963 or the spring of 1964. It is to be launched into a polar orbit with a perigee of 140 mi. and an apogee of 500 mi. It will be launched from Vandenberg AFB, Calif. by a Thor-Agena B rocket system.

STL officials say growth versions of the observatory could be launched by Convair Centaur hydrogen-fueled rockets to carry heavier, more elaborate experiment packages than those which will be aboard the first of the OGO spacecraft. According to the lexicon of the project, the word spacecraft refers only to the uninstrumented carrying vehicle.

Instrument Payload

The word observatory is used for the spacecraft with all its research instrumentation aboard. The initial version of the spacecraft is to weigh 750 lb. The instrumentation payload for EGO and POGO is to weigh about 150 lb., giving each observatory a gross weight of about 900 lb. Centaur-boosted follow-on observatories might weigh up to 1,500 lb. and might leave room for piggy-back satellites according to STL engineers.

NASA specified that the spacecraft and its systems must be designed for 70% reliability after a year in orbit. OGO is intended to be within the present bounds of technology. Miniature integrating gyros and solid state transmitters are about the most advanced components that will be used.

As yet NASA has not announced the list of experiments which will be put in the EGO and POGO observatories but STL has been ordered to make provisions in each spacecraft for 50 experiments dealing with the geomagnetic field, atmospheric composition at orbit altitudes, radiation fields, etc. Some engineers predict that the actual number of experiments will be nearer 30 because of the tendency of experiment instrumentation packages to run overweight.

STL is now preparing to specify design constraints on the experiment packages such as dimensions, power requirements, limits on unbalanced rotating components in boom-mounted packages, telemetry availability, etc. While most of the experiments being considered for the orbiting observatories will advance and amplify the work done in the Explorer program and other early earth-oriented space programs, they may also be used for some solar studies.

An OGO spacecraft will consist of a 6 ft. x 3 ft. x 3 ft. box-shaped body, a pair of wing-like paddles or arrays of solar power cells, a pair of experiment packages mounted at opposite ends of an axle through a housing on one end of the body, and several components mounted on booms.

The orientation of OGOs in space

ENGINEERING PRECISION GUIDANCE

Inertial guidance activities at General Electric's Ordnance Department represent some of the most exciting and challenging work areas for engineers with creative abilities. In addition, the Polaris MK 2 Guidance System demonstrates the Navy's long-range requirements for the kind of precision that Ordnance Department engineers and scientists can deliver.

Here is an area that offers personal opportunity as well as professional challenge. A formal performance review is made annually for each professional employee and top contributors reap the benefits of a high promotion ratio. These promotions, together with expanding program activities, have resulted in a number of openings for qualified engineers and scientists. We would welcome the opportunity to provide details.

Present and anticipated growth emphasize technical opportunities in these areas . . .

- **Electronic Systems Engineering**
- **Digital Computer Engineering**
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- **Guidance and Navigation Engineering**
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FOR MORE INFORMATION, write in confidence to:

Dr. W. B. Walker, Manager
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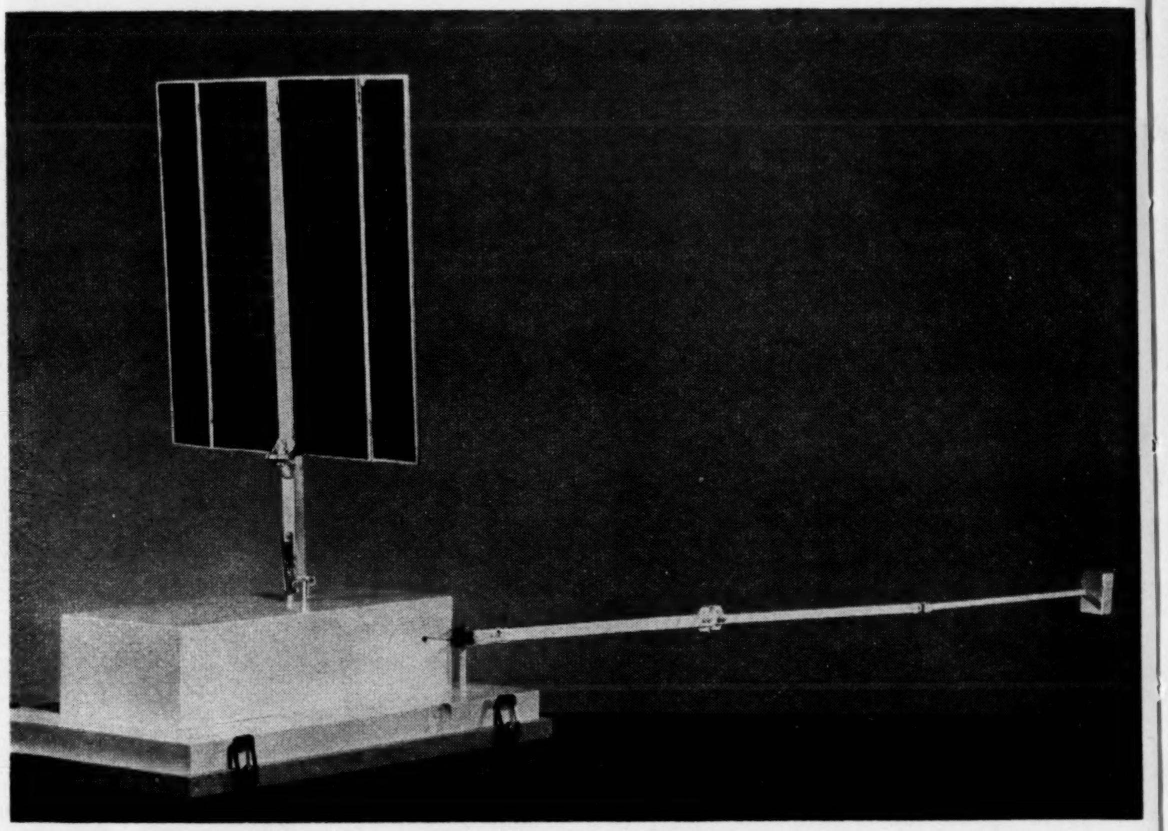
General Electric Company
Pittsfield, Massachusetts

All qualified applicants will be considered for employment without regard to race, creed, color, or national origin.
167-02

GENERAL ELECTRIC



STL MOCKUP shows the proposed arrangement of the folding boom designed to hold an experiment package away from the rest of the instrumentation contained in the satellite.

will be controlled and 15 experiment modules will be accommodated inside the rectangular body in position to look inward toward earth or outward into dark space. Six of the modules will extend completely through the spacecraft and should inherently be capable of looking both ways. Instrument packages to observe the sun are to be mounted on the outer ends of the two solar cell paddles because the paddles will always be rotated to face the sun. The instrument packages will be unpressurized. The only pressurized compartment in the observatory will be the paddle motor and drive case. Pressure will be kept at about 15 psi.

The NASA specification requires that each observatory accommodate experiments in at least two boom-mounted packages at a distance of at least 15 ft. from the body of the spacecraft or any other appendage. These will be reserved for experiments which are unusually sensitive to gas and magnetic interference from the other experiment packages or which produce this sort of interference with the other experiments. There are likely to be four other external experiment packages mounted on 4-ft. booms but this part of the design is not well defined yet. The 4-ft. booms may also carry the three communications antennas. For packaging inside the nose fairing of the Agena B launch vehicle, the booms will be designed to fold. Telescoping booms are not being used because of the possibility of trouble with confined gas.

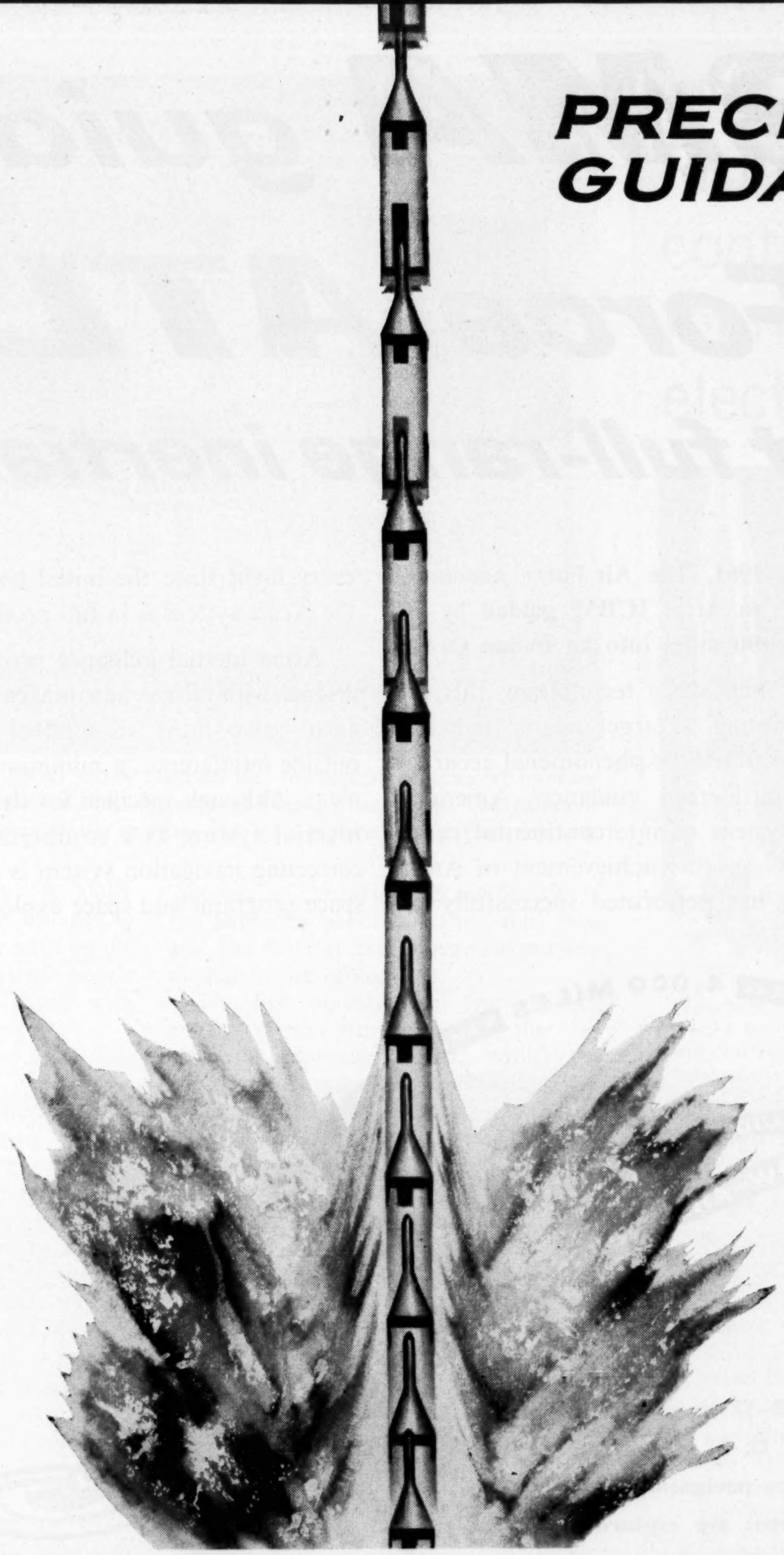
Mounted at opposite ends of an axle on one end of the rectangular body will be a pair of Orbital Plane Experiment Packages (OPEP) gyro-referenced to point sensors or material collecting inlets into the plane of the orbit. The two-package OPEP design was selected to give the vehicle more aerodynamic symmetry. The density of the atmosphere near the planned perigees is great enough to produce a measurable drag force which will tend to disorient the vehicle if it is asymmetrical. STL engineers believe aerodynamic symmetry of the OPEP installation will cut the gas consumption of the attitude control gas jet reaction system by a factor of 10.

Program Cost

The letter contract signed in January and extended once since then provided for a program duration of about 42 months. NASA's original public statement set the value of the contract at $15 million but space program officials say the final cost is more apt to be between $20 million and $25 million. The final contract still is being negotiated. The spacecraft will be constructed at the new STL facility in Redondo Beach, Calif.

Information for the spacecraft attitude control system is drawn from four horizon scanners fixed rigidly on the bottom of the box-like body and from sun sensors on the solar cell paddles. Control power to orient the spacecraft is provided by three momentum wheels and a jet reaction system exhausting compressed argon through six rigid nozzles mounted on a pair of 3-ft. booms which extend from one end of the body. The booms will have coil or bellows-type joints so they can be folded inside the aerodynamic nose fairing of the launch vehicle. Hinged joints will not be used because of the difficulty of preventing leakage of pres-

PRECISION GUIDANCE



POLARIS "ON COURSE"—TIME AFTER TIME AFTER TIME

Over 40 Polaris missiles—with completely operating inertial guidance systems designed by Massachusetts Institute of Technology and produced by General Electric—have been flight tested from land, on the sea, and under the sea.

The repeatedly precise, reliable performance of this MK 1 Inertial Guidance system now is being applied to the advanced MK 2 Polaris Inertial Guidance system by M.I.T., G.E. and Raytheon.

This new, advanced guidance system will be much lighter and more accurate, and will help lengthen the striking power of Polaris from 1200 to 2500 miles.

Polaris Inertial Guidance is typical of the many precision products—antennas, fire control, inertial guidance, launching and handling equipment, torpedoes—being produced by General Electric's Ordnance Department.

166-21

ORDNANCE DEPARTMENT
OF THE DEFENSE ELECTRONICS DIVISION

GENERAL ELECTRIC

100 PLASTICS AVENUE, PITTSFIELD, MASSACHUSETTS

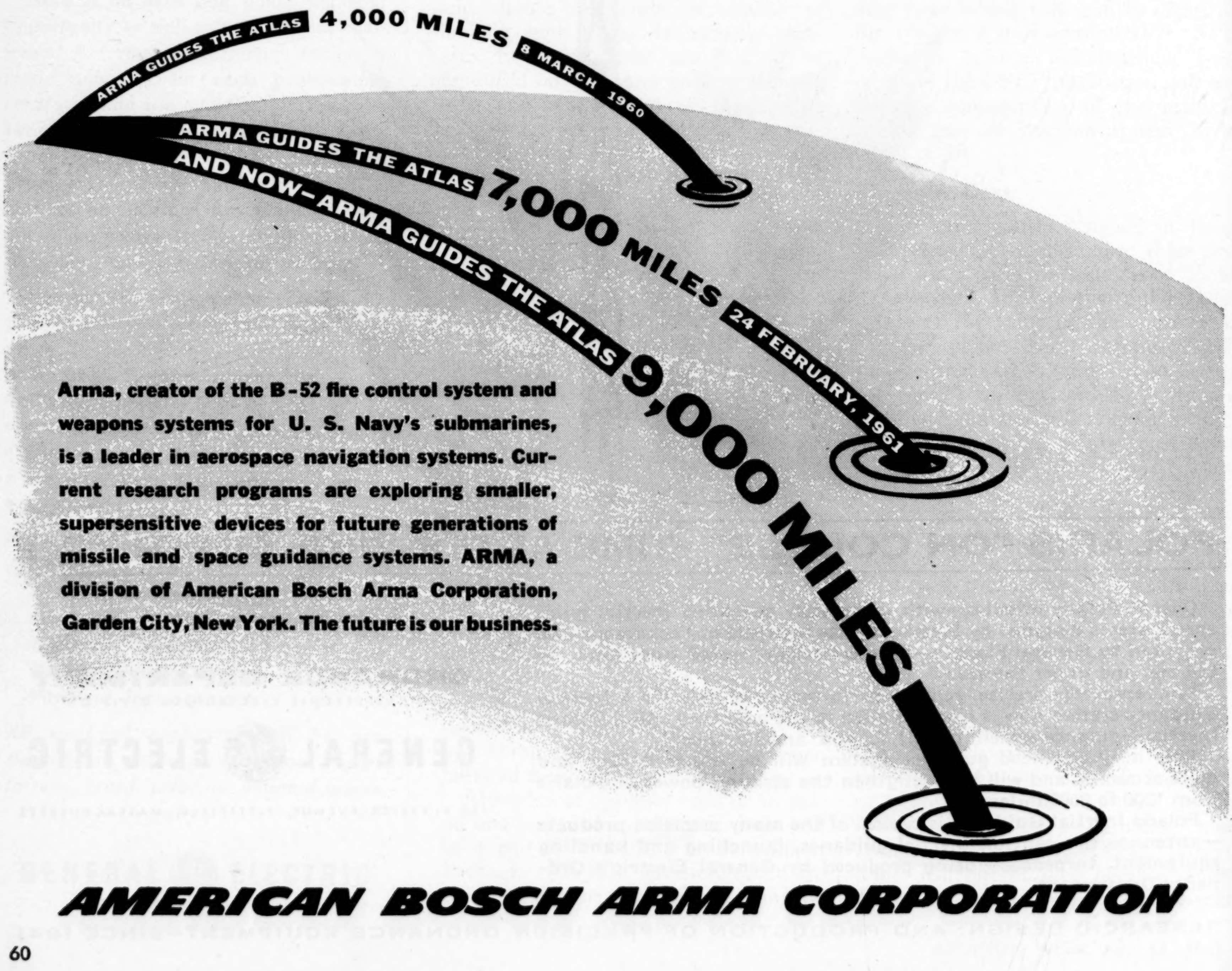
RESEARCH, DESIGN, AND PRODUCTION OF PRECISION ORDNANCE EQUIPMENT—SINCE 1941

ARMA guides Air Force ATLAS in first full-range inertial flight

Cape Canaveral July 7, 1961. The Air Force announced the successful flight of an Atlas ICBM guided by the Arma inertial system 9,000 miles into the Indian Ocean.

A giant step in missile and space technology, this important feat of pin-pointing a target nearly half-way around the world demonstrated the phenomenal accuracy and reliability of Arma inertial guidance—America's first inertial guidance system of intercontinental range accuracy. This flight was another achievement of Arma inertial guidance which has performed successfully on every flight since the initial test in March 1960. Today the Arma system is in full production.

Arma inertial guidance provides our nation's ICBM arsenal with all the advantages inherent in inertial guidance—salvo firing, all-weather capability, immunity to outside interference, a minimum of costly ground equipment. Although specified for the Atlas missile, the Arma inertial system as a completely self-contained, self-correcting navigation system is adaptable to other aerospace programs and space exploration projects.


ARMA GUIDES THE ATLAS 4,000 MILES 8 MARCH 1960
ARMA GUIDES THE ATLAS 7,000 MILES 24 FEBRUARY, 1961
AND NOW—ARMA GUIDES THE ATLAS 9,000 MILES

Arma, creator of the B-52 fire control system and weapons systems for U. S. Navy's submarines, is a leader in aerospace navigation systems. Current research programs are exploring smaller, supersensitive devices for future generations of missile and space guidance systems. ARMA, a division of American Bosch Arma Corporation, Garden City, New York. The future is our business.

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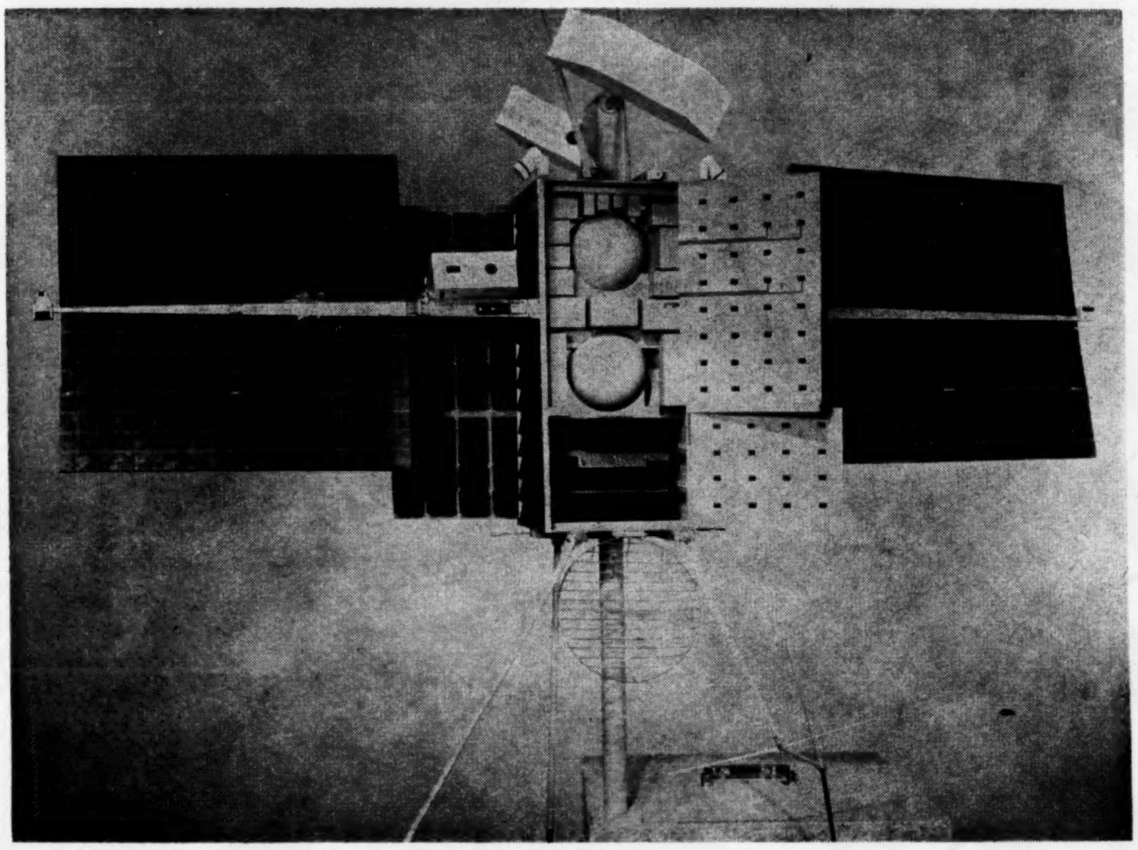

EARLY CONFIGURATION of OGO shows spherical and rectangular experiment modules inside the box-like body. Two Orbital Plane Experiment Packages are at top. The parabolic telemetry antenna at the bottom of the mockup has been replaced by a Yagi antenna.

surized argon at the hinge. A 15-lb. supply of argon at about 2,500 psi. is expected to last for one year with ample reserves. Each attitude control nozzle will develop about 0.05 lb. thrust with a flow rate of 0.001 lb. per sec.

Momentum Wheels

Cyclic attitude disturbances are to be resisted by the momentum wheels. Since the direction of a cyclic disturbance is repeatedly reversed, the wheels can hold the vehicle steady without a long-term build-up of velocity by accelerating first in one direction, then in the opposite one. The wheels will accelerate in an effort to cancel non-cyclic, cumulative disturbances but eventually will be saturated when they reach their maximum speed. The gas system will then be fired to maintain attitude while the wheels are de-spun.

The momentum wheels cannot be modulated, operate only at maximum torque, and have a 100-sec. time constant since a quick reacting servo system is not needed. Total angular velocity change is controlled by varying the duration of torque. Pitch and roll momentum wheels are to be identical with a torque of 3 oz.-in. and a maximum angular momentum of 1.5 lb.-sec. The yaw wheel will be about twice the size of either of the other two with a torque of 6 oz.-in. and a maximum angular momentum of 6 lb.-sec.

The airplane shape given the spacecraft by the wing-like solar cell paddles makes the axes of rotation picked by STL engineers a little deceptive. The long axis of the rectangular body is the axis about which the spacecraft "pitches." The axle and centerline of the two solar paddles is the "roll" axis and the vertical axis of yaw is perpendicular to the other two.

The first operation of the attitude control system after launch is the "acquisition sequence" during which the spacecraft is maneuvered according to a program while the sensors seek the attitude references. With the paddles parallel to the pitch axis, the attitude control system first causes the spacecraft to pitch end-over-end until the paddles are perpendicular to the plane of the sun. The paddles are rotated to face directly at the sun and the rest of the spacecraft is rolled until the long axis of the box is pointed at the sun. Responsibility for pitch control is then shifted to the earth-seeking system and another pitch maneuver is executed to let the four horizon sensors on the body find the earth while the paddles rotate to remain facing the sun. Three horizon sensors are adequate for orientation. The fourth is redundant to give reliability.

Responsibility for roll maneuvers is then shifted to the earth sensors and the spacecraft is rolled so that the long axis of the body is horizontal with respect to the earth and the sun remains in the planes of the long body axis and the vertical axis. The paddles remain locked on the sun. The acquisition is then complete and the earth sensors keep the responsibility for pitch and roll while the sun sensor controls yaw and paddle angle. Sun sensors may be photoelectric cells or infrared detectors.

As the geophysical observatory makes its orbit around the earth, it pitches or

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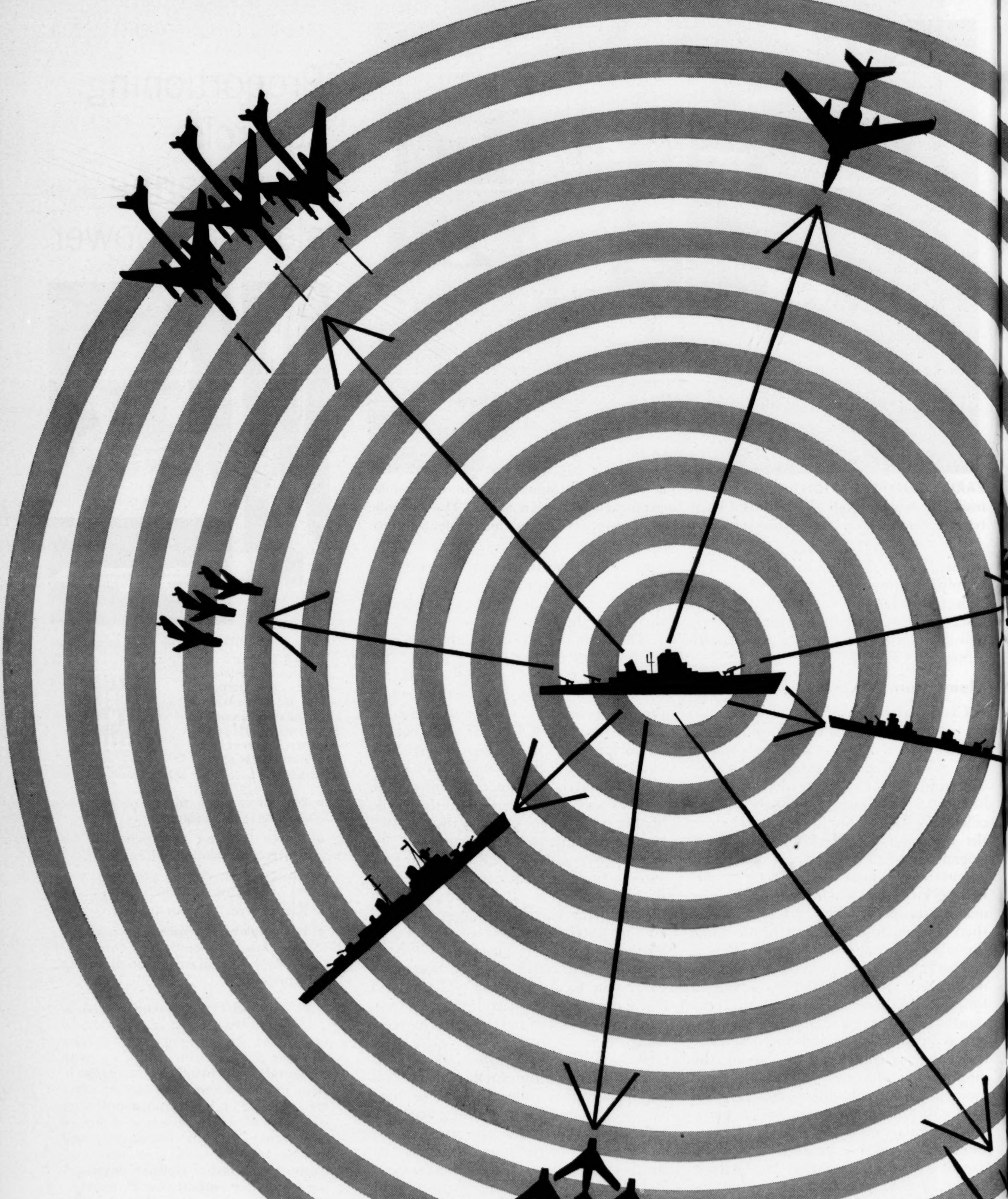

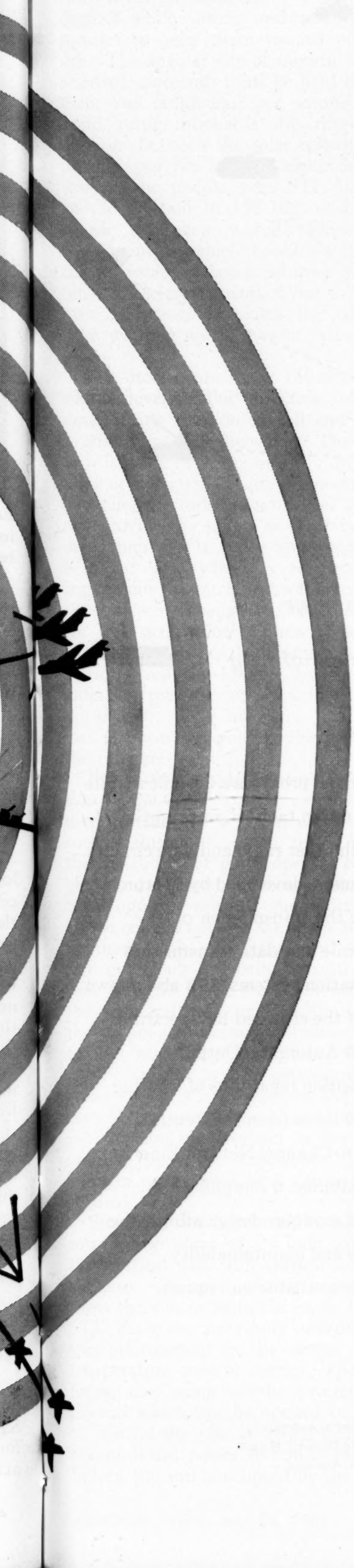

TYPHON...

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Heart of the TYPHON system will be an advanced, long-range search, track, and missile guidance radar that will be designed, developed and produced by the Weapon System Department of the Westinghouse Baltimore Defense Divisions, under prime contract to the Bureau of Naval Weapons. The TYPHON program is under the technical direction of the Applied Physics Laboratory, Johns Hopkins University.

Westinghouse contributions to TYPHON are the result of many years of experience with such basic elements as radar, computers, airborne guidance and control, and search and tracking systems.

TYPHON is another demonstration of how science and systems engineering capability are serving Defense at Westinghouse.

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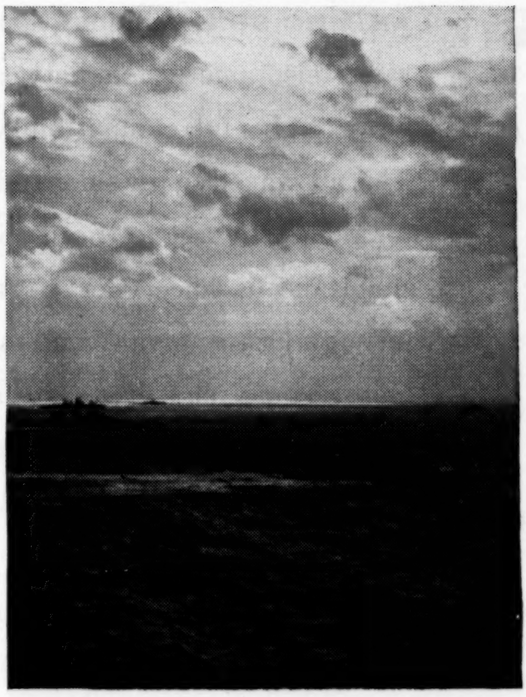

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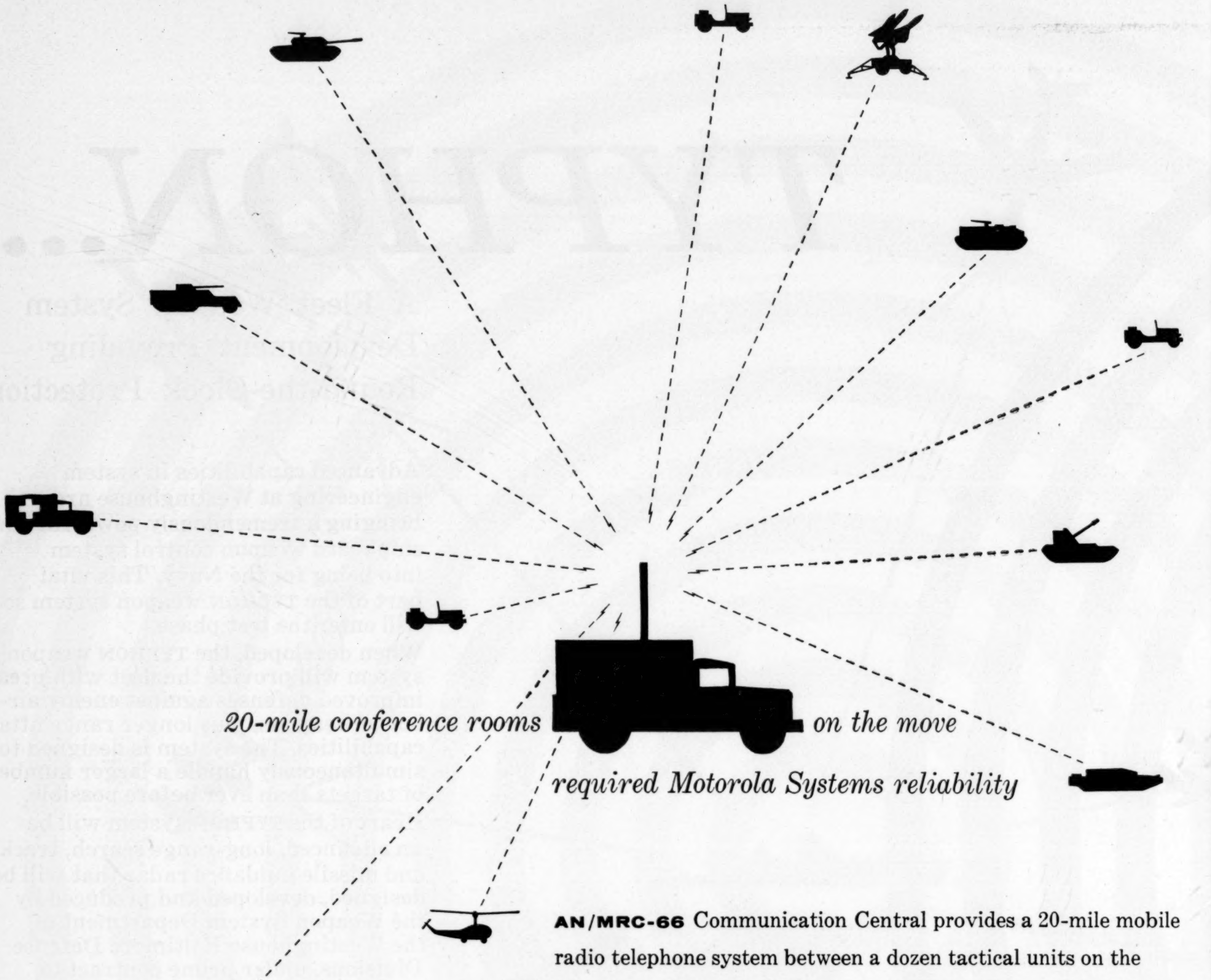
20-mile conference rooms on the move
required Motorola Systems reliability

AN/MRC-66 Communication Central provides a 20-mile mobile radio telephone system between a dozen tactical units on the move...plus full compatibility with other radio and wire circuits. This advanced single sideband concept, developed by Motorola for U.S. Army Signal Corps, offers the transmission of simultaneous voice, teletype, facsimile and data transmission far superior to conventional modulation systems. SSB also allows more channels in a given portion of the crowded RF spectrum and more systems in a given area. ☆ Automatic Output Control insures uniform signal reception regardless of whether vehicles are deployed 100 feet or 10 miles from the Central. Three operating modes—Normal, In-Channel Net and Emergency Net—enhance the basic system flexibility. ☆ Simplification inherent in Motorola's concept and modular design affords the highest possible degree of reliability and maintainability in the field. Detailed information is available on request.

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rolls to keep the same side facing the earth with an accuracy of within two degrees while yawing and rotating its paddles to keep them trained on the sun. The angular rate of motion of the oriented spacecraft must be held to less than one milliradian per second. To avoid using unreliable slip ring connections between the solar cells in the paddles and the internal electrical system at the paddle axle, STL limited paddle rotation to 180 deg. and used simple unbroken wiring. Since the earth-pointing vehicle could not be left free to rotate at one revolution per orbit, STL scientists worked out a "noon turn maneuver" to keep the paddles from winding up the power system wiring.

The noon turn is a 180-deg. yaw which reverses the direction of the slow, steady rotation in roll and pitch so that it unwinds the wiring. The noon turn is made twice per orbit on opposite sides of the earth. Since the noon turn is cyclic, the momentum wheel system can provide the power without becoming saturated. It is for this maneuver that the yaw wheel is to be made larger than the pitch and roll wheels.

Non-cyclic changes or disturbances are the acquisition sequence, aerodynamic imbalances, disturbances at separation from the booster system, solar radiation pressure, etc. Except for the acquisition, these are very small factors or occur but once in the course of the mission.

Two rate gyros to control the rotation of the OPEP packages also will be used by the attitude system as a rate control during the noon turn. While the reliability of gyroscopes is considered to be below the acceptable level for a one-year mission, the addition of a rate control enables the noon turn to be made with more efficiency. If the rate gyros fail, the attitude control system will still make the noon turn but the spacecraft will tend to hunt about the proper attitude and will waste power to halt high rotation rates.

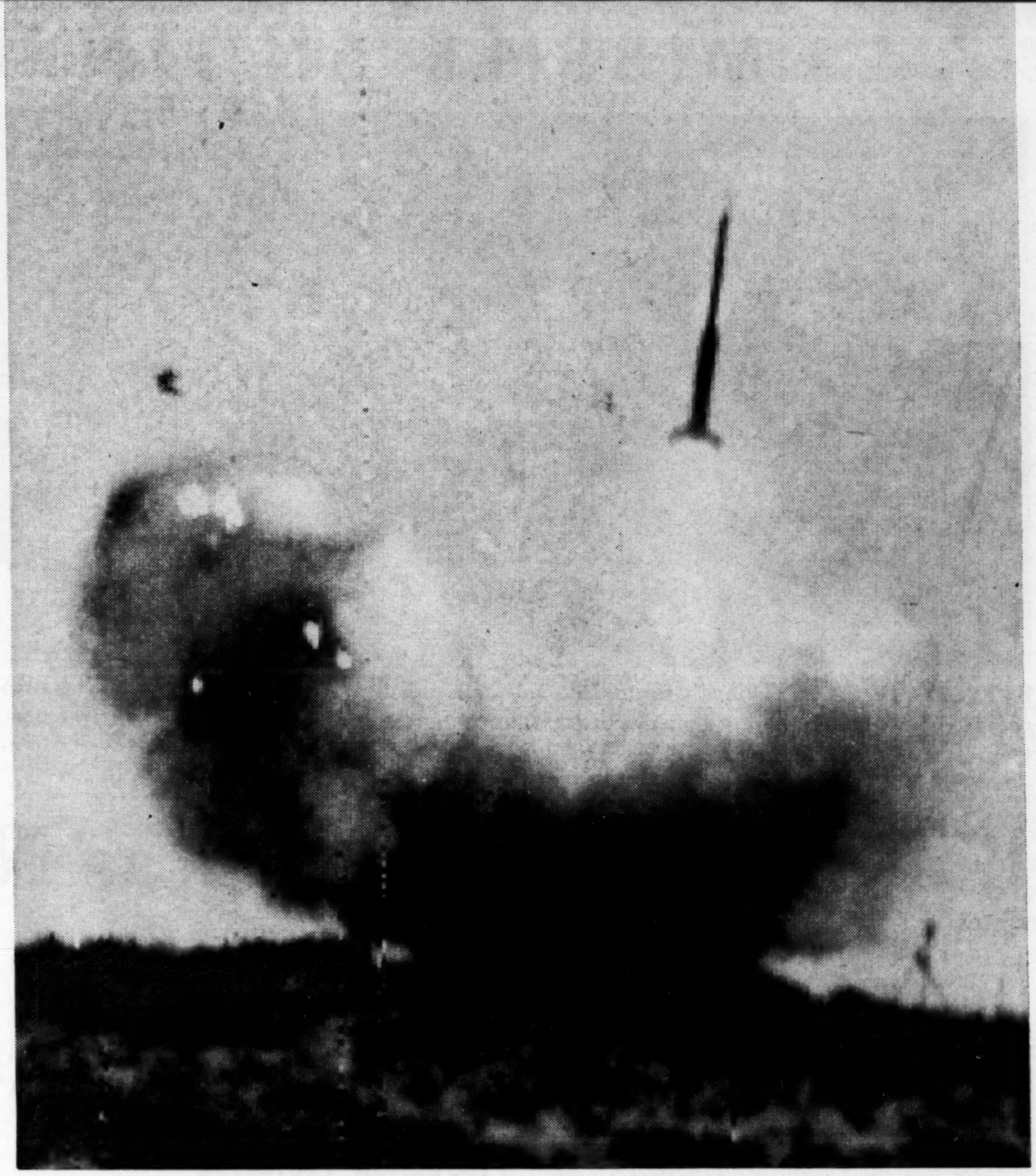
STL engineers are considering installation of a rate gyro in the pitch system to prevent the spacecraft from overshooting the horizon in the earth-seeking phase of acquisition. Other changes in the pitch loop also are being studied.

Since the box is oriented to hold the sun in the plane of its long axis and the vertical axis, the vertical sides of the box will never absorb heat either from the sun or from the earth albedo. STL designers are taking advantage of this arrangement in the design of the temperature control system. The sides facing cold space will be covered with louvers which can be opened or closed to control the rate at which heat from the on-board power system is radiated. When the sun is eclipsed by the earth, the louvers will be closed to retain the power system heat and will be opened again as the satellite emerges in the daylight hemisphere.

Approximately 80 sq. ft. of photovoltaic cells in the paddles will generate 500 watts of power. Experiments are to use an average of 50 watts each and are not to exceed a peak of 80 watts. The power system will provide unregulated power to each experiment. According to specification each experiment will draw 28 volts plus or minus 4.5 volts. Any experiments which need more precise regulation must have their own regulators. One advantage of this is that the failure of one regulator cannot shut down more than one experiment.

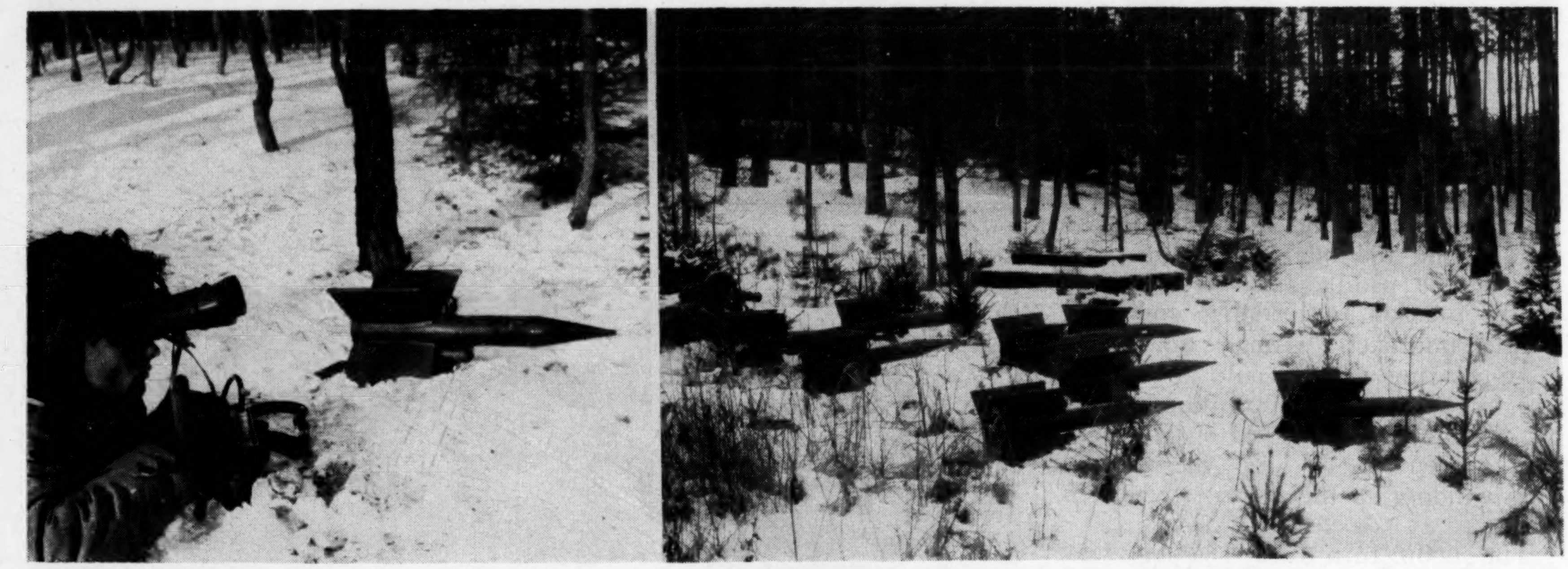
The spacecraft will be equipped with a stable oscillator clock that will be accurate to one part per 100,000. The clock will provide system time pulses for all experiments and can be read out in Greenwich Mean Time. Both funded observatories will carry magnetometers for investigation of the geomagnetic field. There is also a good likelihood that they will carry mass spectrometers capable of identifying atmospheric elements up to an atomic weight of 40.

One telemetry transmitter will handle 64,000 bits per second. There also will be a 64 bit per second system so that Minitrack systems can read out data from the observatory. The magnetometer experiment will have a separate telemetry channel to send direct-modulation analog readout.



Israeli Rocket Stirs Controversy

First rocket launched by Israel on July 5 produced a luminous sodium cloud at an altitude of 50 mi. and set off a political controversy involving Israel, the United Arab Republic and the U. S. Israel, which fired the solid-fueled rocket in secret, first said it was for research purposes only, but Deputy Minister of Defense Shimon Beres later said the program had priority because of "grave defense problems." The UAR then revealed that it was negotiating with U. S. firms for research rockets because National Aeronautics and Space Administration had said it could not supply them on short notice. U. S. State Department has granted an export license for these purchases, but congressional pressure to have State revoke the license is being applied. One congressman said the Simney Corp. of Pasadena, Calif., will sell rockets to the UAR. Israel's rocket, called Shavit II, which means Comet II, was developed with the help of a European nation, believed to be France. Rocket in a picture released by Israel resembles the Lockheed X-17 research rocket.



BATTERY OF EIGHT Cobra wire-guided, anti-tank missiles may be launched and controlled by a single infantryman. In combat, missiles (right) would be more widely dispersed. Controller (left) follows flight of the missile through binoculars mounted on control box. Control stick in his right hand guides missile to target.

Bölkow Pushes Cobra as NATO Missile

By Cecil Brownlow

Munich—Bölkow Entwicklungen, a relatively new and growing research and production firm whose spectrum of interest ranges from space to lightplanes, is pushing its Cobra anti-tank missile system for adoption as a standard lightweight infantry weapon for the North Atlantic Treaty Organization.

It also hopes to sell the unit to the U. S. armed forces and believes its chances are still good despite a recent Army order for France's heavier Nord SS. 11. One new feature which Bölkow believes will add to the Cobra's foreign sales potential is a folding fin version now under development for easier transport in a smaller package over difficult and/or dangerous terrain.

West German Order

The wire-guided, low-cost Cobra, with a maximum effective range of approximately 1,750 yards, has been ordered in quantity by the West German Defense Ministry and is now being evaluated by the armed forces of Italy and The Netherlands.

If accepted by one or more of the NATO nations within Europe, Bölkow probably will grant licensed production rights to firms within the individual countries involved. The same would hold true for any U. S. orders. Bölkow already is turning out the missile in quantity to meet West German military requirements and has signed a license agreement for U. S. production of the Cobra by Daystrom, Inc.

Sales to other European nations and/or the U. S. would represent a major milestone in the reconstruction of the West German industry which, since 1945, has been an importer rather than an exporter as it consumed the techniques necessary to close the technological breach caused by the 10 years of forced inactivity following World War II.

Production Prototype

First production prototype of the present Bo 810 Cobra was built in 1959 with the specific intent of providing the West German army with an effective lightweight anti-tank missile system that could be carried along with its support equipment by an infantryman on foot.

Weighing a total of 22 lb. and 38 in. long with warhead in place, the Cobra has a body fabricated from .7-in.-thick cardboard. Four stub wings located at the rear of the body and their individual spoiler assemblies are made of plastic. Only metal housing used is the hollow charge warhead. The aluminum warhead casing, which encloses a 3.3-lb. black powder charge, weighs 2.2 lb. for a 5.5-lb total.

Carrying handle is located between the two upper wings. Behind that are the battery unit plus a flare assembly to facilitate identification and tracking as the operator guides the missile towards its target.

Internally, the Cobra has a 12,000 rpm. gyro assembly for rolling stability mounted directly behind the warhead adapter ring, which, unlike some Cobra counterparts, permits field changes from one type charge to another.

Behind the gyro is the solid-propellant sustainer rocket and a spool assembly tube containing 1,970 yards of thin guidance cable composed primarily of alternating silk and copper strands. Original design called for a steel cable, but tests showed it tended to snap during abrupt maneuvering, and the copper-silk combination was decided upon instead. Bölkow, if possible, eventually would like to adopt a plastic cable, but no derivatives have been found thus far in which the efficiency has not been impaired by various electrostatic problems.

Rear of the fuselage is protected by a waterproof removable lid containing 6.6 ft. of launching cable which is connected to an anchor peg before firing and provides the electrical impulse that activates the solid-propellant booster unit.

Booster Location

The booster itself is located beneath the fuselage between the two lower wings with its nozzle canted downwards at a 22-deg. angle to provide the necessary lift at takeoff.

The operator, who requires approximately 20 hr. of training for his task, monitors the Cobra flight from a portable 7.2-lb. unit containing a "joy stick" for elevation and directional control, a selector switch that enables him to launch as many as eight missiles in succession, a firing switch and a pair of binoculars for observation. The unit, without binoculars, is 6.4 in. wide, 9 in. long and 5.5 in. high.

Launch cables from the maximum of eight missiles one operator can handle are connected to a common junction box which, in turn, is joined by cable to the operator's control unit.

In operation, the Cobra approaches

the target at a speed of 279 fps., or approximately 190 mph. Time between launchings by an individual operator with several missiles on hand depends largely upon the length of flight of each unit. About 18 sec. is required for a maximum-range flight of 1,750 yards.

For the first 100 ft. of its horizontal trajectory, the Cobra flies its own course independently of the operator to rule out the possibility of human error before the missile has gained sufficient altitude for corrective action to be taken. The initial 100 ft. is covered in approximately ½ sec., with the missile gaining 10 to 15 ft. altitude during this time. Aerodynamic forces build up to the point where the operator has full elevation and directional control after the Cobra has covered about 160 ft. from the launch site.

Booster unit burns for a total of 0.6 sec., and then the sustainer cuts in for another 18 to 20 sec. to carry the Cobra to its target. An acceleration switch located just behind the warhead prohibits the sustainer from igniting until after the booster unit is burning properly.

Through his binoculars, the operator visually guides the missile to the target using electrical impulses transmitted by his control stick motion. Reference point is the tracking flare during daytime launches or the glare of the sustainer exhaust at night. In an area where a number of Cobra units have been deployed, each operator can be assigned a specific flare color to minimize the confusion if several missiles should be in the air at the same time.

After the initial uncontrolled boost to altitude, the operator normally brings the Cobra down again to within a few feet of the ground and then, finally, onto a direct line with the target. The flight profile can vary, however, and the missile can be maneuvered to fly over or otherwise avoid hills and trees or to intercept a moving tank, whose maximum speed would be about 15 mph.

Over-all, the missile has a turn radius of 70 deg. and can make a full circle after traveling a total distance of about 1,300 ft.

German army regulations prescribe that the Cobra be on line with the target for at least the last two seconds of flight whenever possible. This, of course, cannot be done at the missile's minimum effective range of 1,300 ft. which it could cover in just under five seconds if no evasive action was required, and Bölkow officials say it is not necessary.

The Cobra warhead has a percussion fuse on the nose tip and a detonator at the base of the hollow charge which, as a safety precaution, is activated by an automatic timer two and one-half seconds after firing. The timer is set into motion by the acceleration forces at launch. As an added precaution, there can be no detonation on impact with the ground, only when the warhead strikes an object with the resistance of heavy metal.

In Bölkow tests, the warhead has penetrated steel armor plate of up to 24 in. in thickness, the equivalent of any known to be in the heaviest Soviet tanks.

The 16.5-lb. polystyrol plastic storage and carrying case for the Cobra is divided into four sections that are freed when two quick-release metal straps are unfastened. Warhead and missile body are carried in separate sections of the case. The case is of waterproof construction and can be floated across rivers or other bodies of water during tactical exercises.

A plastic bag housed in the case contains 65 ft. of missile cable for connecting the Cobra to the junction box when the missile is placed in a dispersed position as well as a metal launching plate. Use of the plate is optional and designed to ensure maximum booster thrust and to minimize the amount of debris and dust raised at launch.

In the field, an infantryman can carry a loaded container in each hand, with the control unit, 26.1 lb. junction box and an additional reel of cable slung over his back. Total weight of this equipment is about 119.5 lb.—44 lb. for the two missiles, another 33 lb. for the carrying cases, 7.2 lb. for the control unit, 35.3 lb. for the junction box and additional cable reel.

For increased mobility, the Cobra also can be mounted aboard jeeps or personnel carriers. On the U. S. jeeps used in Germany and The Netherlands, a total of four missiles have been placed in a large fixed launcher rack positioned in the rear-seat space. In Italy, however, four have been located on either side of the Fiat jeep in launcher racks

Bölkow Expands Research and Production Capabilities

Munich—Bölkow Entwicklungen K. G., which cut its teeth on the design and manufacture of gliders after its formation in 1956, is developing into a major research and production arm of the West German military and industry.

Founded by Dr. Ludwig Bölkow, who formerly had been associated with Messerschmitt for a number of years, the company's scope of interest now includes gliders and lightplanes on one end of the scale, anti-tank missile systems and helicopters in the center and research rockets, space and infrared research on the far end. Present projects include:

- **Bölkow 207 four-place low-wing lightplane powered by a 180-hp. O360 Lycoming engine. Although the first production models are just beginning to appear, Bölkow has over 30 orders on hand and hopes to reach a delivery rate of 8 aircraft per month. The 207, with a cruising speed of 127 kt., sells for approximately $13,700 in Germany.**
- **Bölkow Jr. all-metal two-seat aircraft with a cruising speed of 125 kt. Manufacturing rights for the plane were recently purchased from a Swedish firm, Malmi Flight Industry. Production will begin later this year. First prototype of the plane was built in the U. S. under the designation BA-7 by designer Bjorn Andreasson, a Swedish citizen working for Convair at the time. Projected German selling price is about $6,000.**
- **Bo 102 Helitrainer, essentially a single-rotor single-seat helicopter mounted on a revolving ground support. Helitrainer, designed to give the student the basics and feel of flying a helicopter while tethered securely to the ground, has been sold in Germany, Spain, France and Sweden. Thirteen have been built thus far.**
- **High-speed rotor system with a novel approach towards eliminating hypersonic tip speeds. Company now is building a small piston-engined helicopter to match with the rotor system for flight evaluation trials.**
- **Extensive work on an advanced follow-on system to replace its lightweight Cobra anti-tank missile designed for infantry use.**
- **Missile research that thus far has led to the development of a solid-propellant high altitude rocket with a design altitude of 50 min. Rocket is now in the mockup stage.**
- **Space research largely centered around payload capabilities. Under West German government direction, Bölkow probably would play a major electronics role in any common European space program.**
- **Infrared detection techniques for missiles and aircraft under government contract. Work probably includes efforts to find means of detecting low-flying objects that cannot be picked up by conventional radar.**

Headquartered in the Munich suburb of Ottobrunn and with a growing number of subsidiary plants, Bölkow also is a partner with Messerschmitt and Ernst Heinkel Flugzeugbau in one of West Germany's top-priority projects—development of a high-performance aircraft as an entry into the North Atlantic Treaty Organization competition for a V/STOL close-support aircraft now under way.

ENGINEERING
REPORT
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PRECISION SIZE 5 MOTORS
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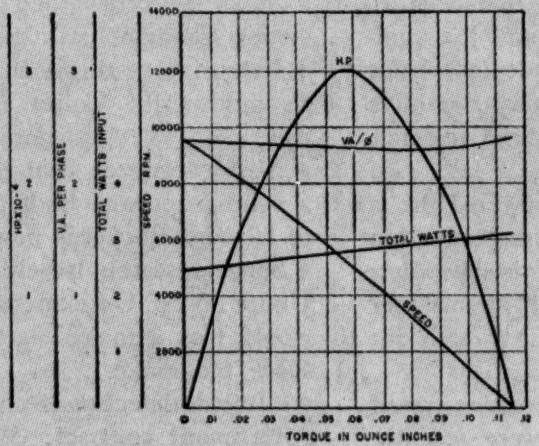
Available for immediate delivery, these miniaturized Bendix® motors (type number CK 1066-40-A1) are designed for applications where space and weight requirements are at a minimum. So small that four can be packaged in a square inch, these motors are ideally suited for missile instrumentation and similar miniaturized applications. The motor has a tapered shaft; however, units may be obtained with other type shafts and with center tapped control windings.

TYPICAL MOTOR CHARACTERISTICS

Voltage	
Fixed phase	26 volts
Control phase	26 volts
Frequency	400 cycles
Stall Current*	
Fixed Phase	100 ma
Control Phase	100 ma
Stall Impedance*	
Fixed Phase	260=184.5+J183.5 ohms
Control Phase	260=184.5+J183.5 ohms
Stall Power Input* (Total)	3.69 watts
Stall Torque	0.138 oz.-in.
No Load Speed	9900
Torque-to-Inertia Ratio (Stall Acceleration)	44,400 rad/sec²
Operating Temperature Range	−55°C. to +70°C.
Weight	0.88 oz.

*With rated voltage applied to each phase.

AVERAGE PERFORMANCE CURVES



For information on these motors—
or similar motors in sizes 8, 10, 11, 15, 20, and 28—write:

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that can be moved to the right or left.

Cobra and its potential as a lightweight defensive weapon for the infantry already has been studied by U. S. Marine Corps officials and by representatives of the Seventh U. S. Army headquartered in Germany. The missile also has been fired on at least one occasion for the Army within the U. S.

In the Seventh Army tests, Bölkow's Emil Wittmann, one of the chief developers of the system, worked for three days with a team of enlisted men who then proceeded to compile a score of better than 70% hits during the demonstrations. Targets for the team, using dummy warheads, included moving tanks as well as stationary vehicles.

In any new U. S. evaluations, the German army will make available the data compiled during its extensive tests of the system prior to the decision to order the Cobra in quantity.

Bölkow also is working on follow-on designs for the Cobra under German government sponsorship—of its 800 engineers and technical personnel, roughly 200 are employed in this field. Goals include lighter weight, greater distance and possibly automatic guidance.

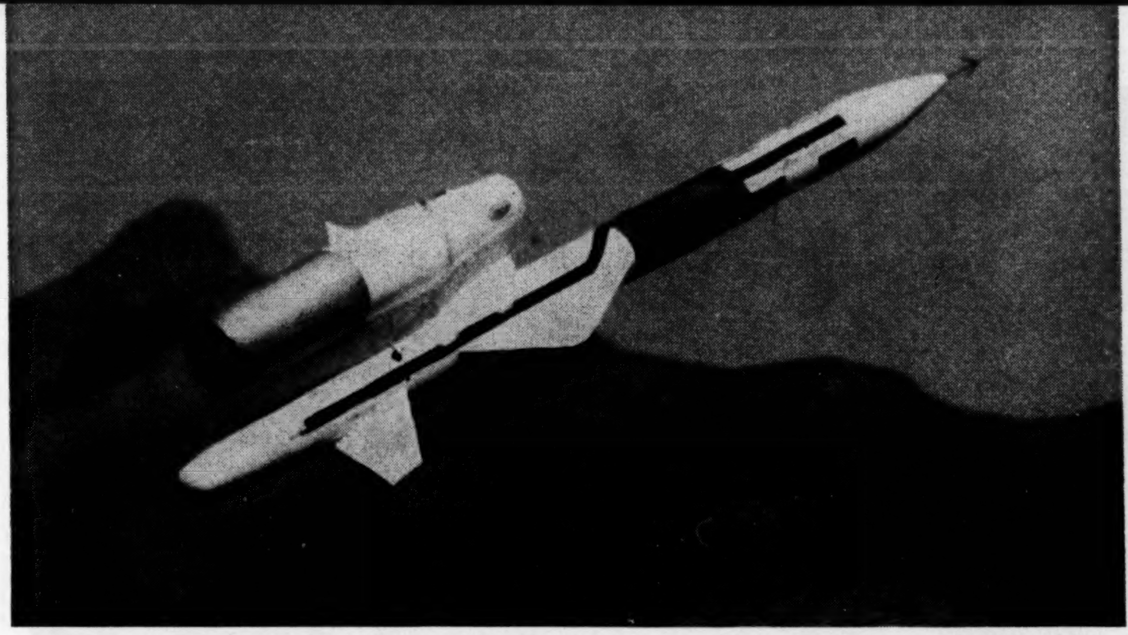
With present techniques, however, automatic guidance imposes weight and logistic problems plus performance disadvantages. A heavy control unit is required at or near the launch site, and a second gyro would be needed to provide one for attitude and one for direction.

Such a system would restrict the maximum angle of turn to about 20 deg., according to present Bölkow studies. A possible compromise could be a semiautomatic unit, including manual override, with only a single gyro in order to preserve the mobility of the current system and maintain the maximum tactical maneuverability.

Basic idea for the present Cobra began to evolve shortly after World War II and in 1956 not long after its organization by Dr. Ludwig Bölkow, Bölkow signed a development and production agreement with two Swiss industrial firms, Contraves and Oerlikon.

"At the time," one official says, "Germany had nothing. We needed the Swiss to make the powder for the rocket motors and for the warhead. . . . Oerlikon also did development work on the ignition system." It was from this association that the Cobra originally received its abbreviated name—Contraves, Oerlikon, Bölkow, Raakete (rocket).

In 1958, with West Germany a member of NATO and Switzerland a neutral nation, the agreement was terminated. All subsequent rights and developments belong exclusively to Bölkow, according to the West German firm.



Army Tests Redhead/Roadrunner Target Missile

First photo of an actual Redhead/Roadrunner target missile shows a 6,000-lb.-thrust Rocketdyne booster lifting the Army-North American NA 273 vehicle from its launcher at White Sands Missile Range, N. M., on its first successful test flight. After the booster was detached, the dorsally mounted Marquardt ramjet engine propelled the 19-ft.-long target missile at supersonic speed on a relatively low-altitude flight. Recovery was made with an automatic parachute system. Redhead/Roadrunner is designed to fly at altitudes from 300 ft. to 60,000 ft. Launching was performed by an Army-North American crew (AW July 17, p. 39). Previous attempts to test-fly the missile were unsuccessful.

Vigilant Sales Pushed Despite Cost

London—Vickers Armstrongs is concentrating on an international campaign to sell its Vickers Vigilant anti-tank missile to Western nations, despite a built-in handicap of high price.

Vickers executives admit the Vigilant costs "about twice" that of comparable missiles, but the team is pegging its sales pitch on the long-range savings that eventually make the missile less costly than comparable weapons. Project is company-funded.

The company shies from mentioning a firm price, on the grounds that a large order, or group of orders, would shave production costs appreciably. The Vigilant appears to have no particular production line complexities and is the only weapon of its type to include a gyro autopilot for flight control. It is this feature that hikes the cost.

The Vigilant was shown recently at a British Army firing range near Warminster to a large group of NATO representatives and officers from several nations. The missile previously had been shown only once to NATO officers on the continent.

In firing tests, using what British Aircraft Corp. described as 'inexperienced operators," Vigilant scored 12 hits on Centurion tanks in 13 tries. Hits were made at ranges from 600 yards to 1,350 yards on a 40-deg. firing spread.

The Vigilant is designed for an 80-deg. arc of coverage with a single operator. The missile pack weighs 49 lb. (in-flight weight is 31 lb.) and attains speeds up to 350 mph. Vigilant can be fired in 12 sec. from first sighting of an enemy tank, since the carrier also serves as the launch pad. When set up, Vigilant is aimed on a 30-deg. angle.

The solid propellant is a double-base cast developed by I. C. I., Ltd., and the warhead utilizes the hollow charge technique. Cruciform wings on aft sections contain a flap device for aerodynamic control by the operator, who sights on the aft flare through a binocular device mounted on a pistol-grip. Control is by thumb button, similar to that used for jet fighter trim controls.

Control impulses are transmitted along a thin wire, of which 1,700 yards are coiled inside the carrier. Power is from a small battery usually carried in the operator's shirt pocket. There is little smoke on firing, and the aft flare cannot be seen by the target tank.

Vigilant is a sturdy weapon, as evidenced by immediate firing after an air drop. Vickers claims the missile can pull up to 7g. On the Warminster tests, the only miss was due to a break in the Vigilant wire coil, which Vickers said was the first in more than 100 firings.

Col. H. Lacey, of the BAC Guided Weapons Department, said a Vigilant operator can be trained by a Vickers-developed simulator and three practice shots. Annual training shots need be no more than two or three Vigilants per year, he claimed. For airlift purposes, Lacy said a Bristol Britannia can carry 85 solders and up to 200 Vigilants.

For follow-on, the Vigilant is being considered as a helicopter-mounted weapon and also on a Ferret scout car, which could haul two Vigilants in readiness positions. Current research is on extending the Vigilant's range and on various versions of warheads.

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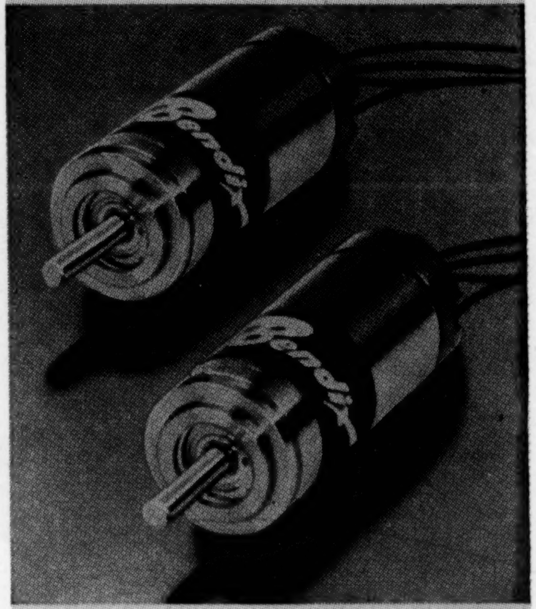

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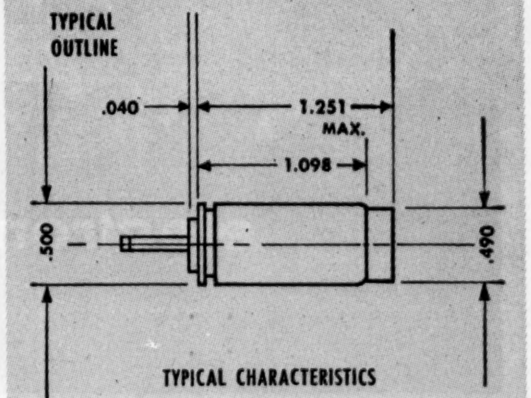

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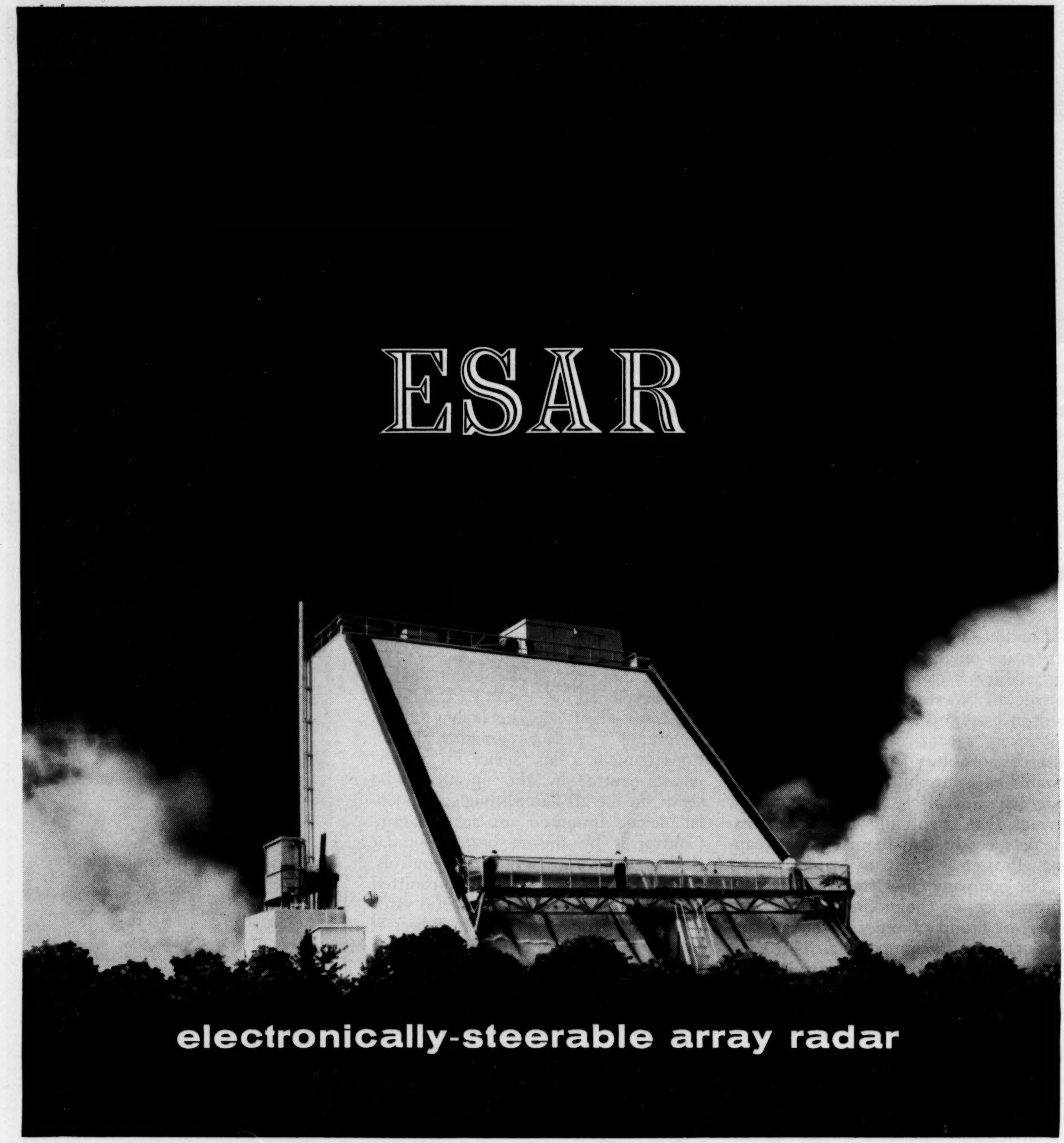

An experimental model ESAR radar which demonstrates the fundamental aspects of electronically-steerable array radar is now undergoing test at Bendix Radio. The successful culmination of this experimental effort could provide the basis for a new technology leading to the development of multiple function, electronically-steerable array radars capable of searching, tracking, deep space communications and command control. ESAR is part of Project DEFENDER, the program of advanced research in ballistic missile defense directed by the Advanced Research Projects Agency, Department of Defense. The ESAR contract is administered by the Rome Air Development Center of the U.S. Air Force. Organizations working on advanced space concepts are invited to contact Bendix Radio for details, and to see ESAR in operation.

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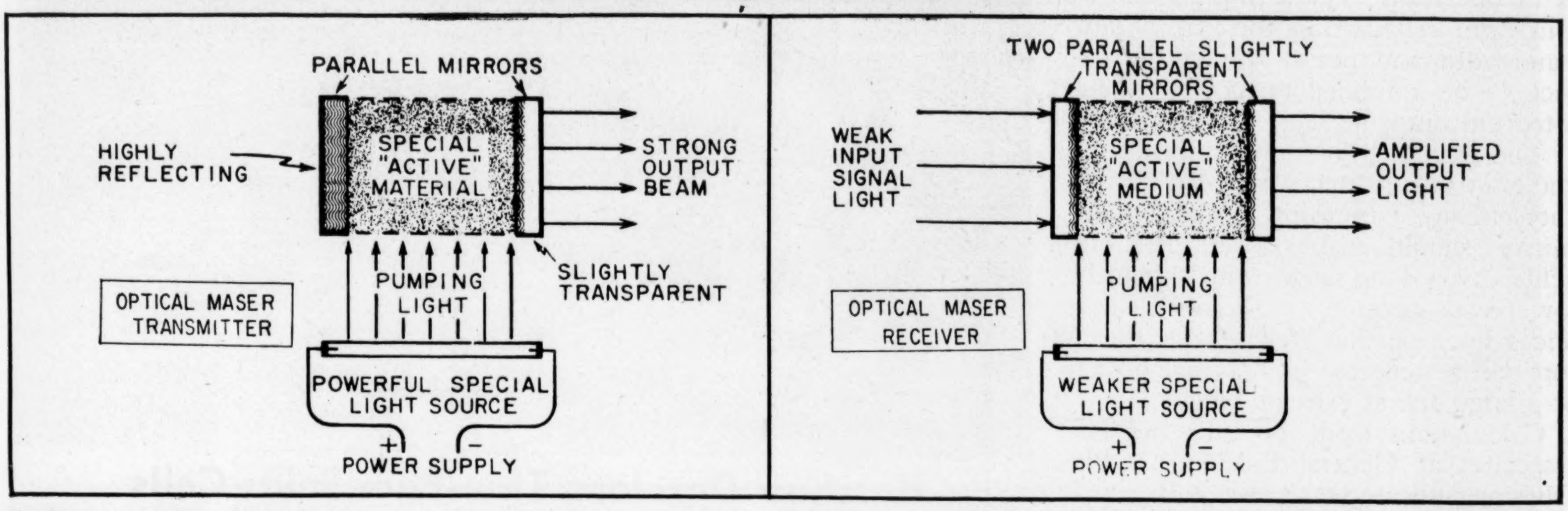


OPTICAL MASER (laser) holds many advantages for space vehicle navigation use with the development of a laser receiver expected soon. The receiver (right) will function with laser transmitter (left) which already has been demonstrated. Receiver resembles transmitter except that pumping light source is weaker and second mirror is partially transparent to admit signal from distant transmitter.

Laser Challenges Radar for Space Use

By Philip J. Klass

Williamsburg, Va. – An optical maser (laser) receiver, with unusual characteristics that will make it extremely useful for space vehicle navigation, can be expected in the near future, perhaps within several months, Dr. Cecil B. Ellis of General Precision, Inc., predicted here during the recent annual meeting of the Institute of Navigation. The report was co-authored by Ivan A. Greenwood.

The optical maser receiver, when used with an optical maser transmitter which already has been demonstrated by several companies (AW July 18, 1960, p. 96), should provide a system which can measure distance (range) and velocity with far greater accuracy than is possible with radar.

Equally important for space vehicle use, the optical maser system is expected to be considerably smaller, lighter and less complex than radar, and to consume far less electric power. (For a description of experimental laser radar developed by Hughes Aircraft, see AW Feb. 27, p. 61).

In principle, the optical maser (laser) receiver is expected to resemble closely the laser transmitter, Ellis said. In the laser transmitter, a suitable active material (solid, liquid or gas) is placed between two parallel mirrors and excited from a special light source, called "pump," which usually surrounds the active material.

Energy from the pumping light excites atoms in the active material, causing them to emit light which is reflected back and forth between the two mirrors, where it is re-inforced. This light in turn stimulates other atoms to emit light which is in phase (coherent) with the existing light and thereby greatly increases its intensity.

If one of the two mirrors is lightly silvered, the light within the active material will pass through and emerge as an intense beam of extremely small width. This extremely narrow beam width, which Ellis predicts will be reduced to only 0.2 of a second of arc within a year, is one of the extremely useful characteristics of the device. Another is the fact that its bandwidth also is extremely narrow. Low-power devices built to date have exhibited a frequency spread of only a few parts in 10^{11}, and it appears that a spread of only one part in 10^{12} or 10^{13} can be achieved ultimately, Ellis said.

Laser Receiver

In a laser receiver, both mirrors would be only partially silvered. This will permit passage of internally generated light from one mirror, as with the transmitter, and also will permit external light from a separate laser transmitter to enter through the other mirror. Additionally, the intensity of the pumping light source would be reduced to just below the point where stimulated emission (maser action) begins.

Under such conditions, when light from a separate laser transmitter impinges on one mirror, part of it will pass into the active material, triggering the stimulated emission from the active material which will produce a much more intense (amplified) beam from the output mirror at the opposite end. This output will be directed at a photoelectric cell to convert the variations in emitted beam intensity into equivalent electric signals.

Two important conditions must exist if the laser receiver is to operate as described, and these endow the device with extremely useful properties:

- **Frequency (wavelength)** of the incoming maser transmitter beam must match precisely the resonant frequency of the receiver, which is determined by the choice of active material used and the physical spacing between the two mirrors.
- **Direction** of the incoming beam must be precisely aligned with the optical axis of the mirrors. Otherwise the incoming beam will be reflected out of the material before it has made sufficient traverses between the two mirrors to stimulate atom emission. This means that a laser receiver will amplify only that fraction of any light beam falling on it which is very closely parallel to its axis, within a divergence angle which corresponds to the divergence angle of the beam emitted from a transmitter of similar design.

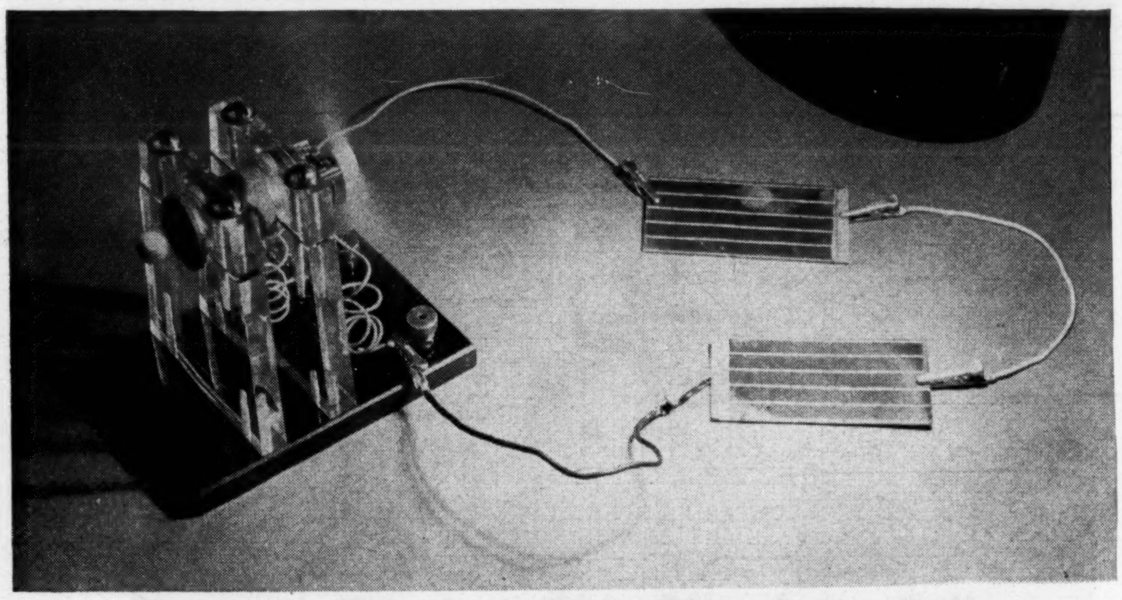
These inherent characteristics mean that a laser receiver is readily able to distinguish between a desired signal and unwanted background light, Ellis said. For example, a laser receiver can operate in bright sunlight and amplify a very weak signal from a companion laser transmitter which enters its sensitive axis, while practically ignoring the extraneous sunlight.

"Even if a receiver maser is pointed directly at the sun, it will not be receiving much amplifiable energy since it can only accept a bandwidth which is a million-millionth of the visible spectrum, and a solid angle which is a hundred millionth of the sun's disk as seen from the earth," Ellis said.

The laser receiver also has the advantage of not being subject to thermal noise as is most microwave equipment because materials at normal temperatures do not produce significant light in the visible part of the spectrum, Ellis pointed out. While it is true that the active medium glows while the device is in operation, only a tiny fraction of this light falls within the very narrow bandwidth and beamwidth of the device to be amplified further by stimulated emission, he said.

The extremely narrow beamwidth of the laser transmitter, which can be further enhanced by using a small output mirror, should enable a laser radar to achieve very long ranges with extremely low power because the beam is filled and a large portion of its energy therefore will be reflected from a small object or a large one at extreme ranges.

Calculations made by Ellis and his associates at General Precision's GPL Division indicate that a laser radar capable of measuring distance from one space vehicle to another with which it wants to rendezvous should be able to measure this distance with an error of no more than one mile when the two vehicles are 100,000 mi. apart. Assuming the target vehicle has a diameter of 20 ft., the laser radar would require an average beam power of only 66 watts. Complete laser radar system power consumption should not exceed 800 watts during system operation. This figure includes timing and output display power consumption and is based on a probable 10% efficiency for the laser itself, Ellis said.



Harshaw Develops Thin-Film Solar Cells

Cadmium sulphide film solar cells developed by Harshaw Chemical Co. deliver sufficient power for small motor to drive two propellers when cells are illuminated. Harshaw is one of a number of organizations conducting research on thin film solar cells which give promise of reducing cost-per-watt and weight-per-watt of solar cells and offering possibility of preshaping films to contours of space vehicles.

When a laser radar is used to measure space vehicle altitude above the surface of a planet for landing guidance, its narrow beamwidth offers another advantage where planet terrain is mountainous. The narrow-beam laser will measure altitude over a small spot rather than an average altitude over a large area as with relatively broad-beamed radar.

The laser also appears suitable for measuring vehicle velocity by means of doppler shift of the reflected beam energy. At a relative velocity of 2,900 kt. between a space vehicle and a planet, the doppler shift from the transmitted frequency will be one part in 100,000. This is many times the bandwidth of the returned signal which makes it extremely easy to measure the doppler

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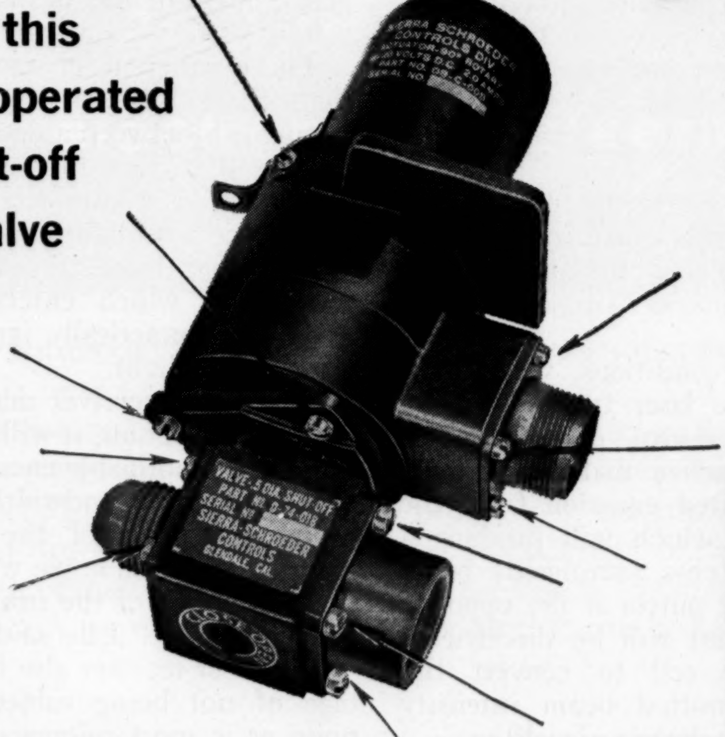

Use of Long-Lok Self-Locking Screws on this Sierra-Schroeder Controls Model 74-01B Valve eliminated lock wire, provided repeated re-use—simplified field service. Long-Lok Self-Locking Screws are used on the housing of this valve as well as on the gear train mounting where an extremely restricted assembly area makes the use of lock wire a time consuming and prohibitively expensive operation.

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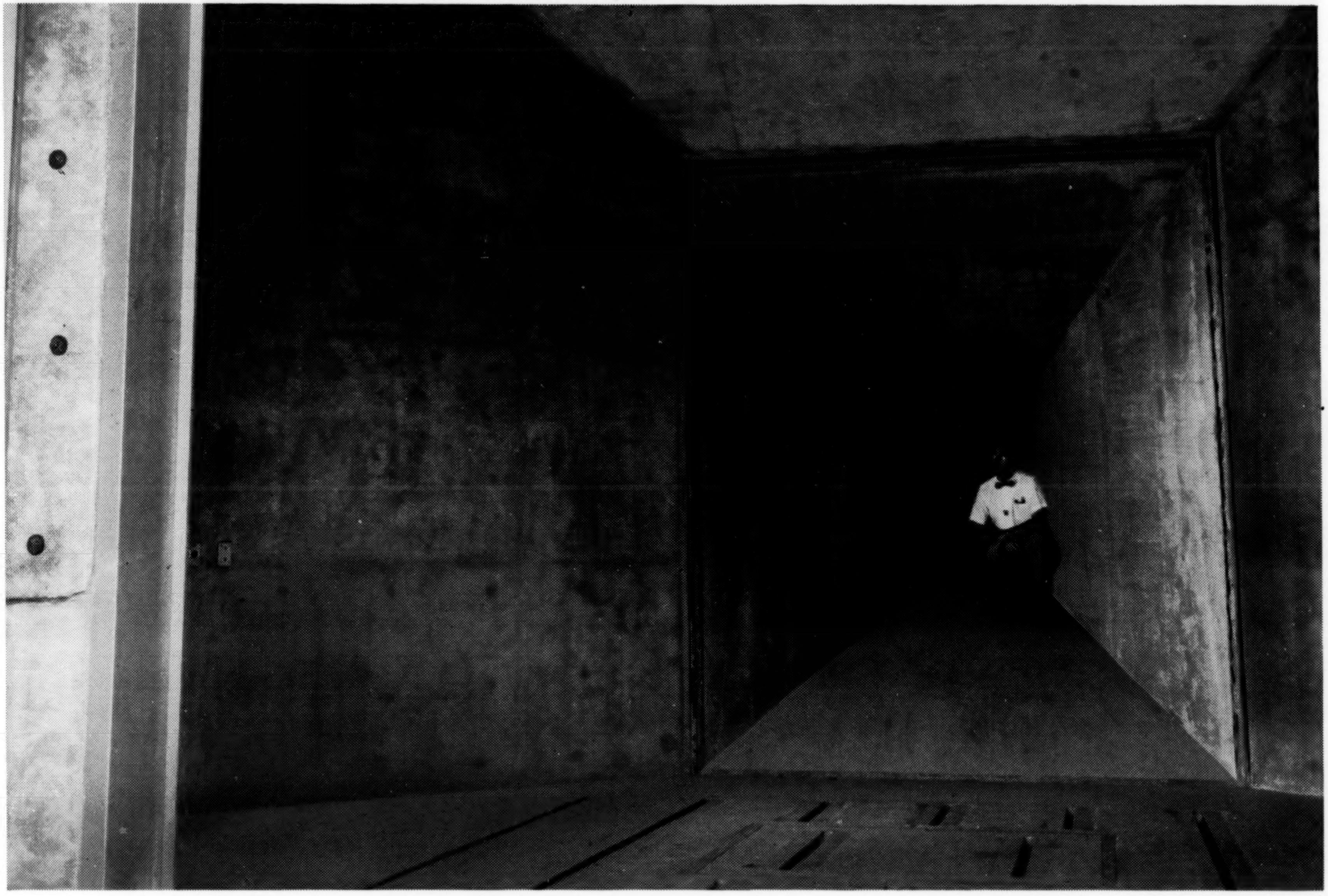


Mach 3 Technology

Torturing aircraft structures with the world's largest "gramaphone" To predetermine in-flight stresses on an aircraft as advanced as the Air Force's Mach 3 B-70 Valkyrie, it was necessary to make sweeping advances in the state-of-the-art of testing procedures.

One way the Los Angeles Division of North American Aviation met this challenge was to build the largest, loudest acoustical test chamber in the world. Here, a mammoth 47 foot by 30 foot concrete loudspeaker horn can blast aircraft structural specimens with up to 170 decibels of noise. This is the equivalent of 54,000 five-tube radios going full blast, yet ingenious soundproofing keeps this noise to no more than a discreet whisper outside the lab. The noise inside the lab is so great that the heat generated could ignite fiber glass insulating material.

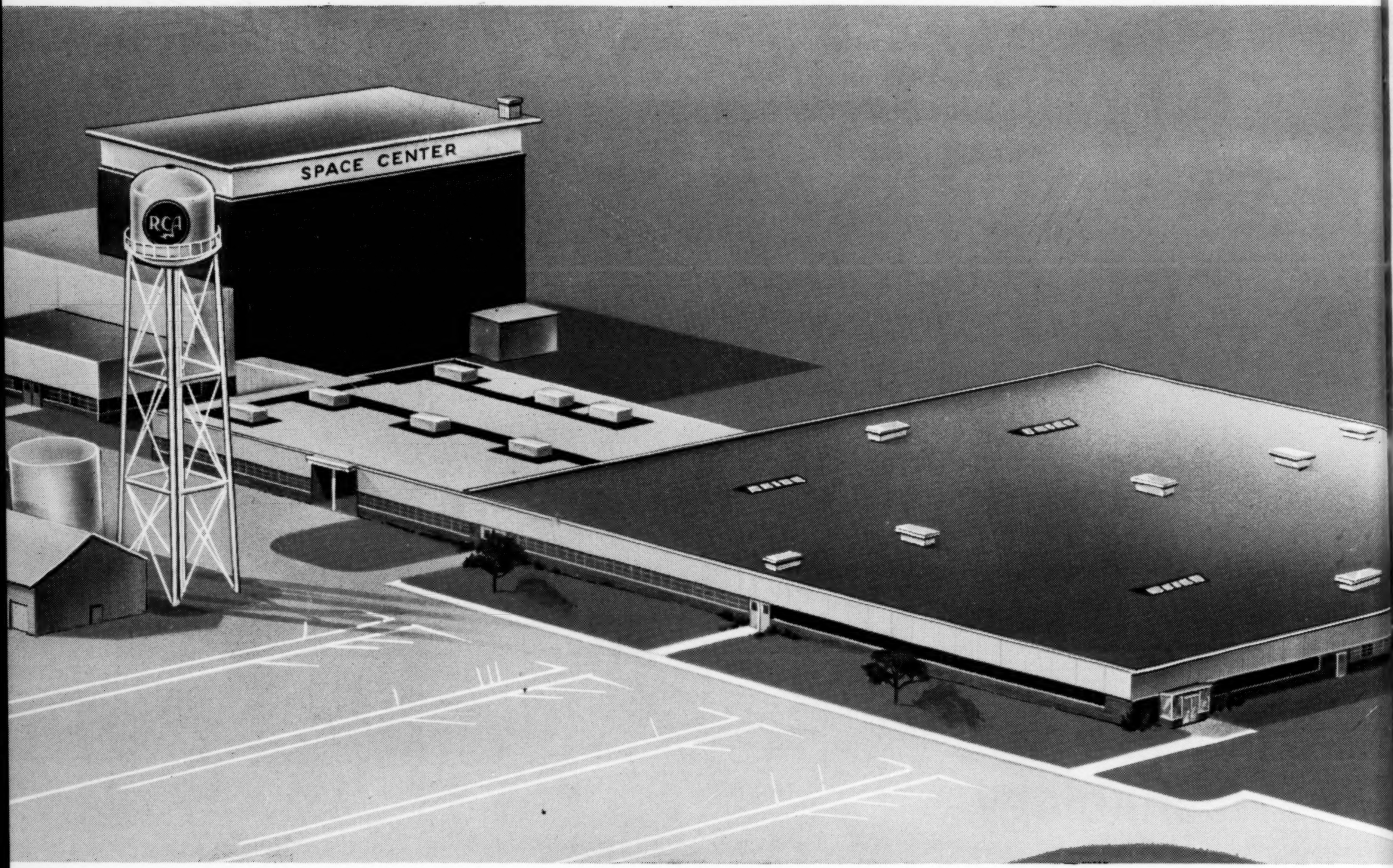
Specimens up to 6 feet by 25 feet can be tested in the acoustical lab. It has the capacity for: progressive wave as well as reverberant sound fields; grazing or normal incidence specimen orientation; discrete frequency or random noise at sound levels up to 170 dbs; thermal environment testing from −100°F to +1200°F; frequencies of 50 to 10,000 cycles per second. This is indeed a remarkable facility for acoustical testing, fatigue testing, and vibration testing.

This giant acoustical laboratory can not only carry out testing on tomorrow's Mach 3 aircraft, but can perform tests on aerospace craft still ten years from reality. The lab is only one of the many that the Los Angeles Division has developed to conquer problems of space age flight.

Builders of the B-70 Valkyrie

THE LOS ANGELES DIVISION OF **NORTH AMERICAN AVIATION**

New RCA Space Environment Facility Brings Outer Space Down to Earth...



. . . Will pretest coming generations of U.S. space vehicles and satellites at environmental extremes assuring reliable long life operation and optimum performance.

Included in the new environmental equipment and facilities being built and installed at the RCA Astro-Electronics Division at Princeton, N.J., are the following advanced testing devices:

Vacuum-Thermal Chamber—measuring 28 feet in diameter and 25 feet high to accommodate the coming generations of space vehicles and satellites and meet all vacuum-thermal requirements.

Vibration System—provides 28,000 pounds peak force for sinusoidal, and 28,000-pound rms force for random motion testing.

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The entire RCA Space Center, which contributed to the success of projects such as SCORE, TIROS I, TIROS II and ECHO I, continues to be dedicated to the conception, development and production of earth satellites, space vehicles and ground support and information handling equipment. For additional information about RCA's engineering talents and proved capabilities, contact the Manager, Marketing, RCA Space Center, Box 800, Princeton, N. J. And, for a complete description of the new environmental facilities, write for your copy of the brochure "RCA Space Environment Center."

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shift and therefore the vehicle's velocity, Ellis said.

For a doppler laser system, it is only necessary to design the receiver maser so its resonant frequency can be tuned to a frequency as much as one part in 100,000 away from the transmitter maser frequency, Ellis said. A variety of methods of altering the resonant frequency appear feasible, he added. One of the easiest might be to leave a small space between the end of the active medium and one of the two mirrors, which would be filled with an inert gas whose pressure could be externally controlled.

Velocity Altered

By changing the density of the gas, the velocity of the light rays passing through the gas is altered, which in turn will change the frequency (wavelength) of incoming transmitter laser light to which the receiver will respond. By varying the pressure of the gas through a suitable range, the sensitive frequency of the laser receiver could be scanned through the expected range of the doppler shift until stimulated emission occurred. The dial controlling the gas pressure could be calibrated directly in terms of velocity.

For optical masers whose active materials cannot be stimulated by a frequency differing by as much as one part in 100,000, another approach could be used, Ellis said. A small electromagnet could be placed near the material to alter its resonant frequency, using a principle known as the Zeeman Effect.

A doppler laser system, capable of measuring both the magnitude and direction of a lunar space vehicle's velocity relative to the moon at an altitude of about 1,000 mi. above its surface, to an accuracy of 0.1%, would require an average beam power of only 40 milliwatts, assuming measurements were made every eight seconds, according to Ellis.

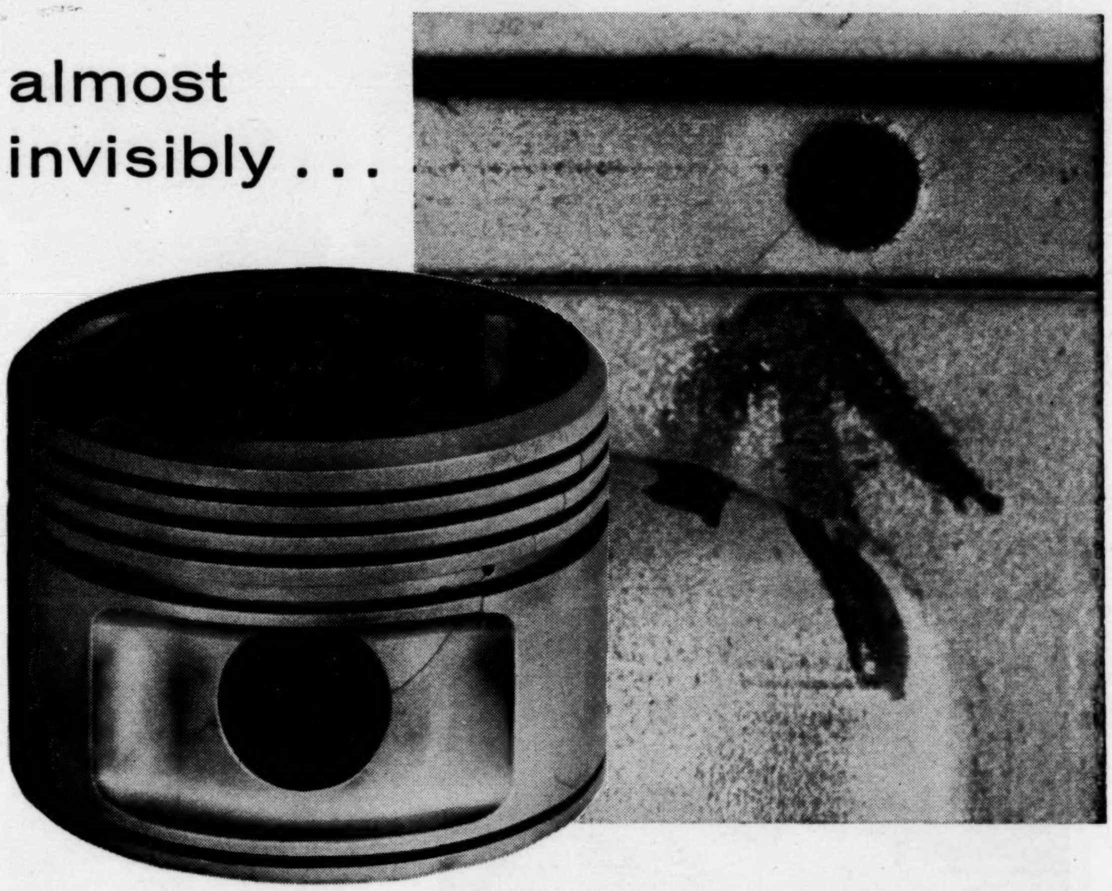
More frequent and/or more accurate measurement would require higher beam powers.

A doppler laser system of this type should weigh about 10 lb. and occupy about one cubic foot, Ellis estimated.

Laser-Radar Comparison

Ellis gave the following generalized comparison between optical maser and microwave doppler systems, assuming the microwave system uses the same diameter antenna as the maser output mirror:

- **If the distant object is large enough** to fill the beam of both systems, as when measuring velocities against the surface of the moon or of a nearby planet, then a detectable doppler signal can be obtained for approximately the same amount of transmitter beam power in both types of systems. However, the accuracy of velocity measurement is vastly better for the laser system whenever vehicle velocity is not exactly perpendicular to the reflecting surface, as for a lunar or planetary landing, because of the relatively large area viewed by the radar beam which produces a large spread of doppler shift frequencies.
- **If the distant object is very small** and its position is not precisely known and cannot be determined except by automatic scanning of a large volume of space and at a wide range of possible doppler velocities, then the target acquisition phase requires about the same beam power for either type system—assuming the same acquisition time.
- **If the distant object is small,** but it can be located by optical or other means to aid in training the laser optical axis on the object, the power advantage always favors the laser, and its advantage increases directly with the distance of the object. Even if a lunar landing vehicle could carry a 60-ft.-diameter radar antenna, a laser doppler system with only a two-foot mirror should provide velocity measurement accuracy which is 2,000 times better, Ellis concluded.



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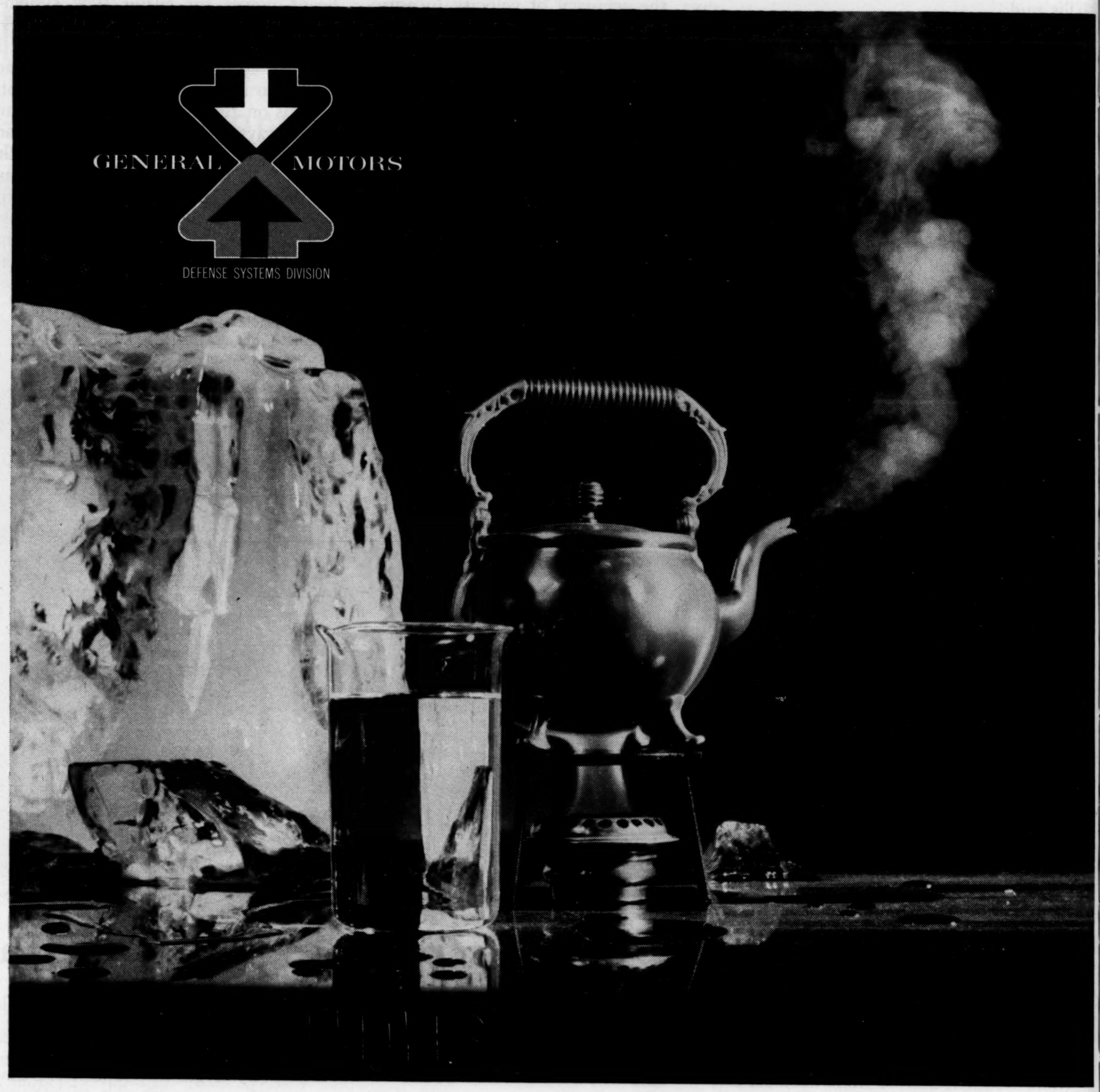

...key to life

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Lightweight, Compact Atomic Clock Built

By Barry Miller

Torrance, Calif.—Unusually lightweight, compact rubidium frequency standard, or atomic clock, which may have wide uses where competitive devices are too bulky or too expensive has been developed and is being marketed by Clauser Technology Corp. here.

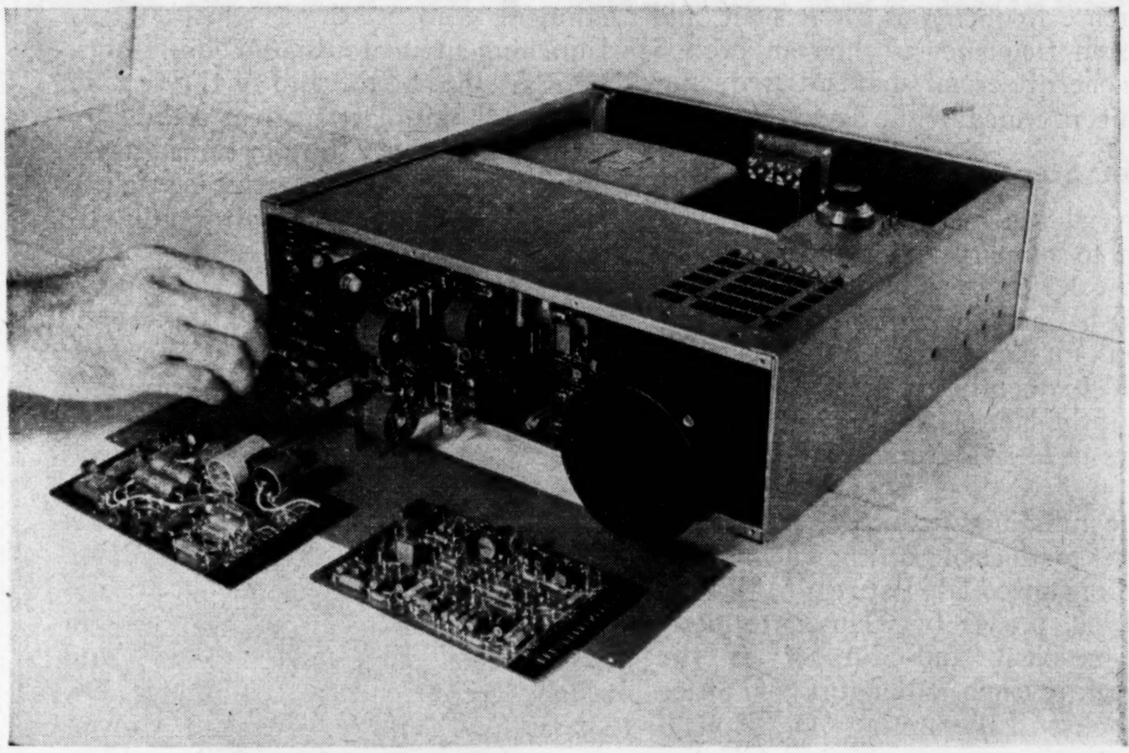
The rubidium standard is one of a broad class of devices which utilize the atomic resonance phenomena in a gas to enable it to provide an accurate and stable output frequency or time standard.

Developed for laboratory and field use, the Clauser standard weighs 30 lb., occupies approximately 1 cu. ft. and draws 40 watts during warmup, 20 watts during normal operation. The company is offering it for $14,800 in single unit orders. An airborne version of this rubidium standard could be packaged into less than ½ cu. ft., according to Dr. Milton U. Clauser, president of the company.

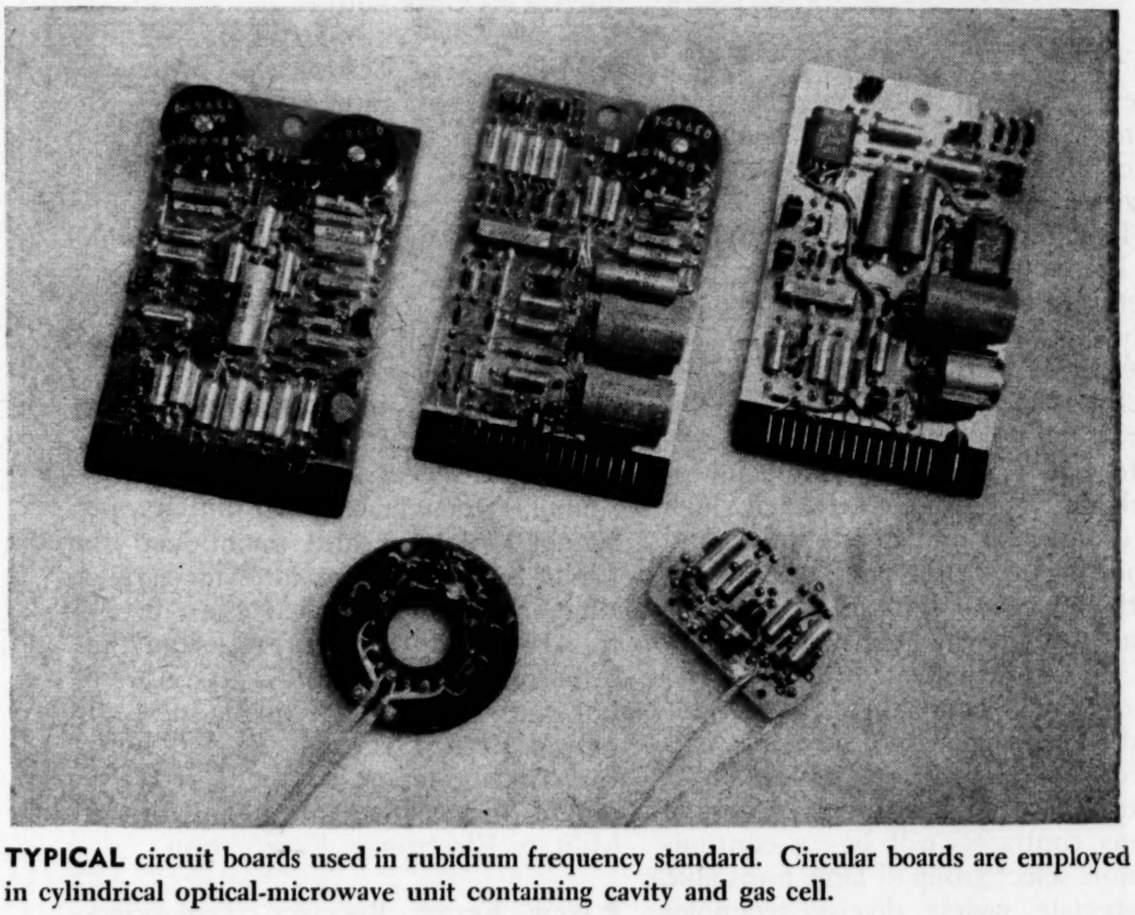
The device is capable of providing outputs to an accuracy of 5 parts in 10^{10} (where accuracy is defined as the degree to which the output frequency conforms to an accepted standard). Stability—a measure of how well the device maintains its characteristics—is 2 parts in 10^{10} (long-term) and better than 5 parts in 10^{11} (short-term), the company says. Short-term stability is calculated on the basis of a series of readings taken at one-second intervals and averaged over a period of about 10 min.

Highly accurate frequency standards perform key functions in a variety of aerospace applications. These include synchronization in communications systems, timing for satellite and space probe tracking stations, in-house frequency standards in scientific laboratories, timing in electronic countermeasures, and timing and coordination for navigation and guidance systems.

While essentially similar to other rubidium frequency standards in its general mode of operation, the Clauser device incorporates a number of engineering modifications which reduce the bulk and complexity of electronic circuitry, contributing to the diminution in size and weight of the unit. In this standard, as in similar ones, the output frequency of a crystal oscillator, selected at some sub-multiple of the resonant frequency of a rubidium gas, is multiplied and applied as excitation to a microwave cavity in which the gas is contained. Resonance is enhanced by the optical radiation from a continuously operated discharge lamp. The amount of optical radiation absorbed in the gas is a function of the relative absorption of microwave energy, hence provides a measure of the departure of the excitation frequency from the resonance of the rubidium gas. An error signal derived from the detection of the transmitted optical radiation corrects the crystal oscillator.



COMPACT rubidium frequency standard, developed by Clauser Technology Corp., occupies approximately one cubic foot, weighs 30 lb. and is designed for laboratory and field use. Black cylindrical package at right contains microwave cavity, rubidium gas cell, excitation lamp, photodetector and preamplifier.



TYPICAL circuit boards used in rubidium frequency standard. Circular boards are employed in cylindrical optical-microwave unit containing cavity and gas cell.

The output of the controlled crystal oscillator then has to be translated from an irrational crystal frequency (submultiple of the rubidium's 6,834.6826 mc.) into usable frequencies. This requires a synthesizer whose complexity depends on the cleverness of the designer's choice of factors by which to divide the oscillator output and emerge with a rational frequency. An important objective in the synthesizer design is to choose a combination of low factors to simplify the divisional circuitry and to eliminate the need for oven control as used in other rubidium standards.

In the Clauser device, the crystal frequency output (4.981550 mc.) is divided in four simple steps—a division by 6, by 5, by 3 and 3 again to provide a total division by a factor of 270. The resulting frequency is mixed with the crystal oscillator output, the undesired difference frequency is filtered out, and the sum frequency is then an even 5 mc., one of several standard frequency outputs provided by the device.

Other Steps

Several other engineering steps were taken to simplify and compactly package the device. In addition, the company says it has analyzed and determined the reasons for lamp aging and blackening which frequently occurs in these devices if the lamp is not properly excited. It says its design corrects for this difficulty.

The rubidium frequency standard is the first product of Clauser Technology, a firm organized late last year (AW Oct. 24, 1960, p. 34) by Clauser, formerly vice president and director of the physical research laboratory of Space Technology Laboratories. Dr. Donald J. Farmer, a senior scientist at Clauser, is responsible for the frequency standard development.

Acceleration Foreseen In Avionic Shakeouts

New York—Mortality rate of small electronic companies will probably increase in the next several years as the industry's growth rate decreases, Henry W. Harding, president of Laboratory For Electronics, told the New York Society of Security Analysts here recently.

Predicting a drop to about 9% per year by 1965, Harding said: "At this lower growth rate, the industry is going to find it increasingly difficult to absorb and justify the extremely high cost of research and development and engineering of prototypes." Adding to this the effects of shifts in the market's military - industrial - consumer proportions, he said, will result in the squeeze-out of small companies. The LFE president said that the survivors, and consequent recipients of the bulk of prime Defense Department electronic systems contracts, will be "a continually more select group of large firms able to integrate widely diverse technologies."

Harding said that the industry cannot expect the electronics portion of DOD's budgets to expand in the 1960s as it did during the 1950s. Repeating a caution now frequently voiced by other industry spokesmen, Harding pointed out that small unit procurement of modern systems, no matter how costly the individual price tag, necessarily results in small total dollar volume.

FILTER CENTER

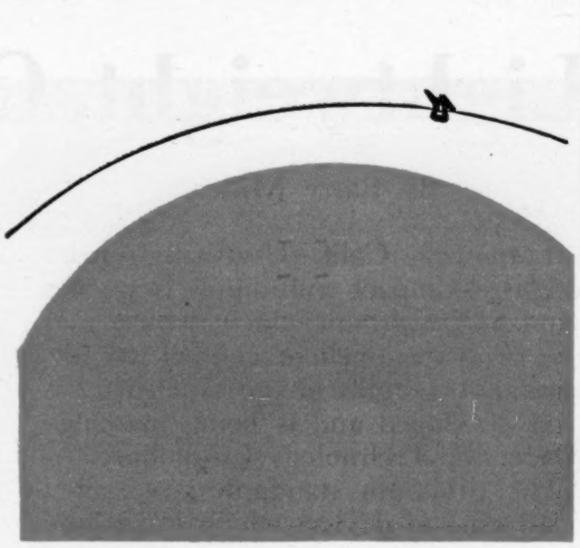
▶ Amateur Comsat by Year's End—Government sources think prospects for launching an amateur radio communications satellite by the end of the year are still good. State Department is studying the foreign policy implications of the proposed radio amateurs' satellite, known as Project Oscar (AW Feb. 13, p. 77), which might be orbited piggyback with a government space shot. One reason for the delay in approving the plan is that the projected amateur radio comsat is neither a government nor a commercial venture and hence falls outside existing rules.

▶ Improved Jamming Technique Reported—Recent psychophysical experiments show that proper choice of jamming signal can make use of power in the speech signal it seeks to disrupt and achieve more effective jamming, Dr. Donald W. Tufts of Harvard University reported at recent Military Electronics Convention in Washington. The experiments also showed that effectiveness of an intermittent jammer is increased if a high interruption rate is used, Dr. Tufts said.

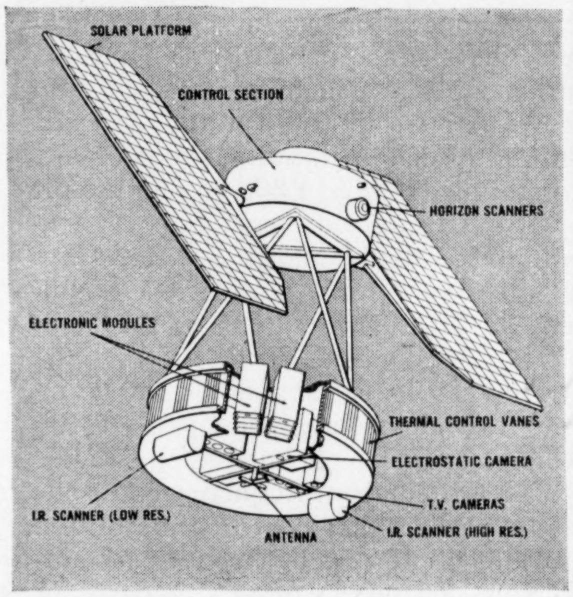
▶ Military vs. Contract Maintenance—Air Force-sponsored study by the Mitre Corp. at an Air Defense Command SAGE direction center to compare effectiveness of military maintenance with private contractor personnel indicates that enlisted personnel are practically as effective as their hired civilian counterparts.

During first seven months of the year-long study, the SAGE AN/FSQ-7 computer was maintained by International Business Machines Corp. personnel, after which ADC military personnel took over and maintained the facility. Under GI maintenance, down time increased somewhat from 0.12% to 0.19% of total time, and mean time to failure dropped from 32 to 28 hours, but mean time to repair failures improved from 1.5 hours to 1.1 hours. Investigation report was made by H. W. Adams and A. S. Morton of Mitre at Military Electronics Convention.

▶ New Ferret Receiver Technique—A new technique for design of ECM ferret receivers, which permits continuous monitoring of a broad frequency range and simultaneously reads out the frequency of intercepted signals with an accuracy of approximately 5%, was described by Dr. John L. Grigsby of Applied Technology, Inc. at recent Military Electronics Convention. The tangential sensitivity of such a receiver would be approximately −70 dbm. while covering the entire frequency



NIMBUS



Nimbus is the second step in NASA's research and development program to study weather technology. Differing from its predecessor, Tiros, Nimbus will view the Earth at all times.

Orbit—Weighing approximately 650 lbs., Nimbus will circle the earth every 108 minutes in a 600 mile-high polar orbit.

Equipment—As many as 6 TV cameras, plus infrared measuring devices, tape recorders, telemetry and command instruments will be contained in the satellite.

Data Acquisition—Cloud pictures and other information will be played back on command to U.S. meteorologists at Fairbanks, Alaska. Foreign scientists, also, will be invited to participate in the program.

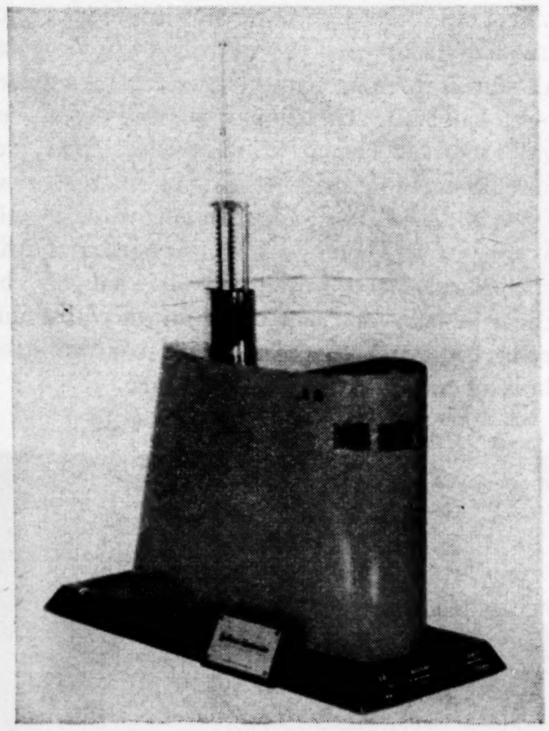
Control and Stabilization—A specially built system will keep TV cameras always oriented toward the earth and permit cameras to view particular sectors of the global cloud pattern.

General Electric's Missile and Space Vehicle Department will provide systems integration for Nimbus, and will develop the control and stabilization system. MSVD is a department of the G.E. Defense Electronics Division. 160-03

GENERAL ELECTRIC

range of two to four gigacycles, Grigsby said. Receiver output could be displayed on a cathode ray tube with angular displacement of the CRT beam with respect to the polar axes representing the frequency and its radial displacement representing the amplitude of the intercepted signal. A complete receiver of the new type is expected to weigh 30 lb. and occupy about one cubic foot, Grigsby said.

▶ **New Malleable Superconductor Developed** – New superconductor material whose cold-worked alloy is malleable and strong enough to be fabricated into wire, bars and strips without loss of its superconducting properties, has been developed by Atomics International, a division of North American Aviation, under sponsorship of the Atomic Energy Commission. New material consists of three parts niobium to one part zirconium. Company says that wire made of new material has conducted 100,000 amperes per square centimeter in a 30,000 gauss field at liquid helium temperatures and is expected to remain superconducting in even higher fields.



Polaris Antenna

Retractable whip-type high-frequency radio antenna for Polaris submarines, developed by Hoffman Electronics Corp., uses new method of tuning to cover spectrum between 2 and 32 mc., as shown in model above. Loading coil, in the form of helix, forms part of antenna so that any energy emitted by helix is added to that from the rest of the antenna. Motor-driven contact can touch helix at any point, changing effective electrical length of antenna system for broad-band operation. Radio operator's control permits antenna and the helix to be raised or lowered as required. Entire antenna can be withdrawn into submarine within 40 sec., Hoffman says. Antenna may also find use in Titan II missile sites.

CALLERY PROPELLANT BRIEFS

Let's talk impulse in space

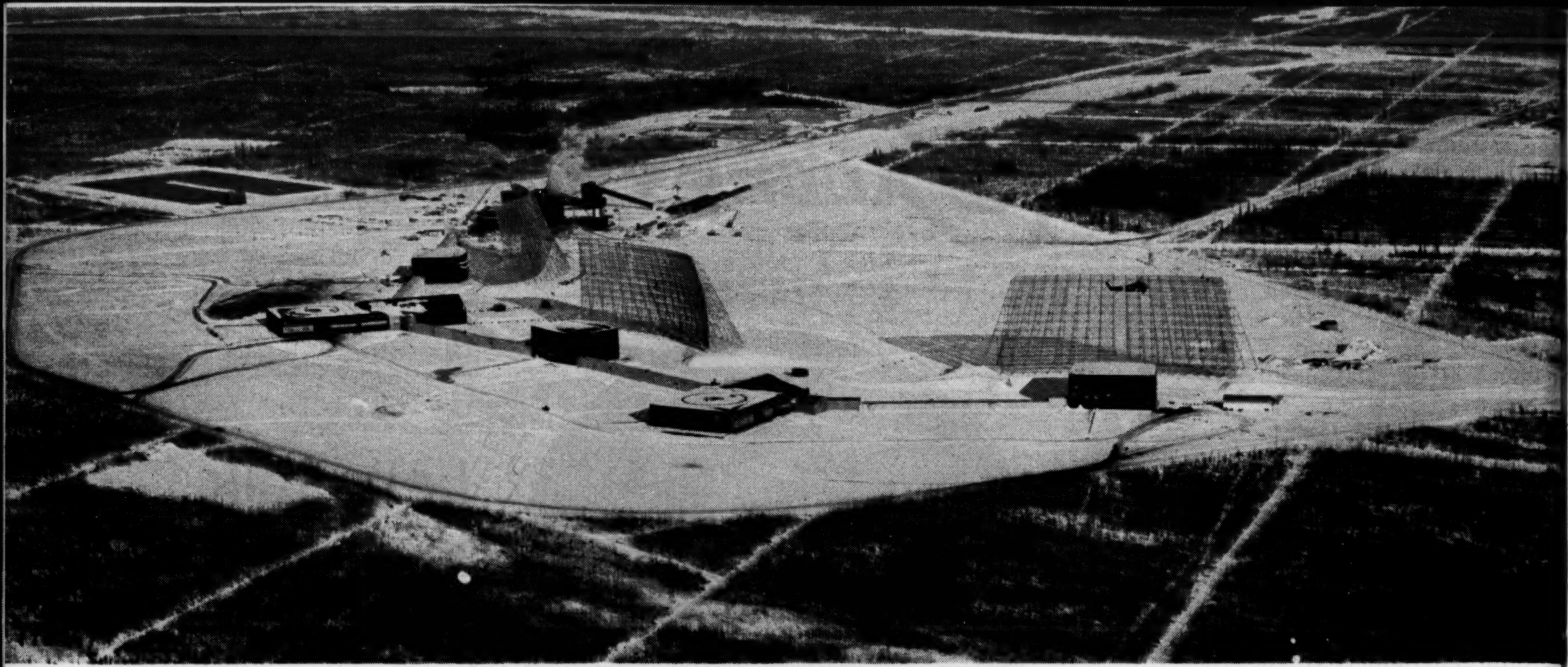
Exotic chemical propellants will often find their most useful applications in upper stages, for course or orbit correction and lunar landing or take-off. Isp values compared at $P_E = 0.2$ psia have a different relationship than when compared at $P_E = 14.7$ psia. Such an approximation of "space" conditions gives a much truer picture of the relative performance of propellant systems. We present (from Callery's new booklet — Propellant Performance Data*) a few excerpts to illustrate the point. As the U. S. standardizes on LOX-RP, LOX-LH₂, and solids, there is still considerable merit in storable liquid systems for specialized jobs in space.

PROPELLANT SYSTEM	SPECIFIC IMPULSE	
	Sea Level 1000→14.7	Space 1000→0.2
H_2–O_2	391	470
B_5H_9–OF_2	367	466
B_5H_9–F_2	360	460
N_2H_4–F_2	363	436
B_5H_9–O_2	327	421
B_5H_9–NF_3	326	412
B_5H_9–H_2O_2	316	405
B_5H_9–N_2O_4	306	391
B_5H_9–ClO_3F	306	390
RP–O_2	300	379
B_5H_9–ClF_3	290	368
N_2H_4–N_2O_4	291	354
CH_2–NO_2ClO_4	278	349

*Available upon letterhead request from:

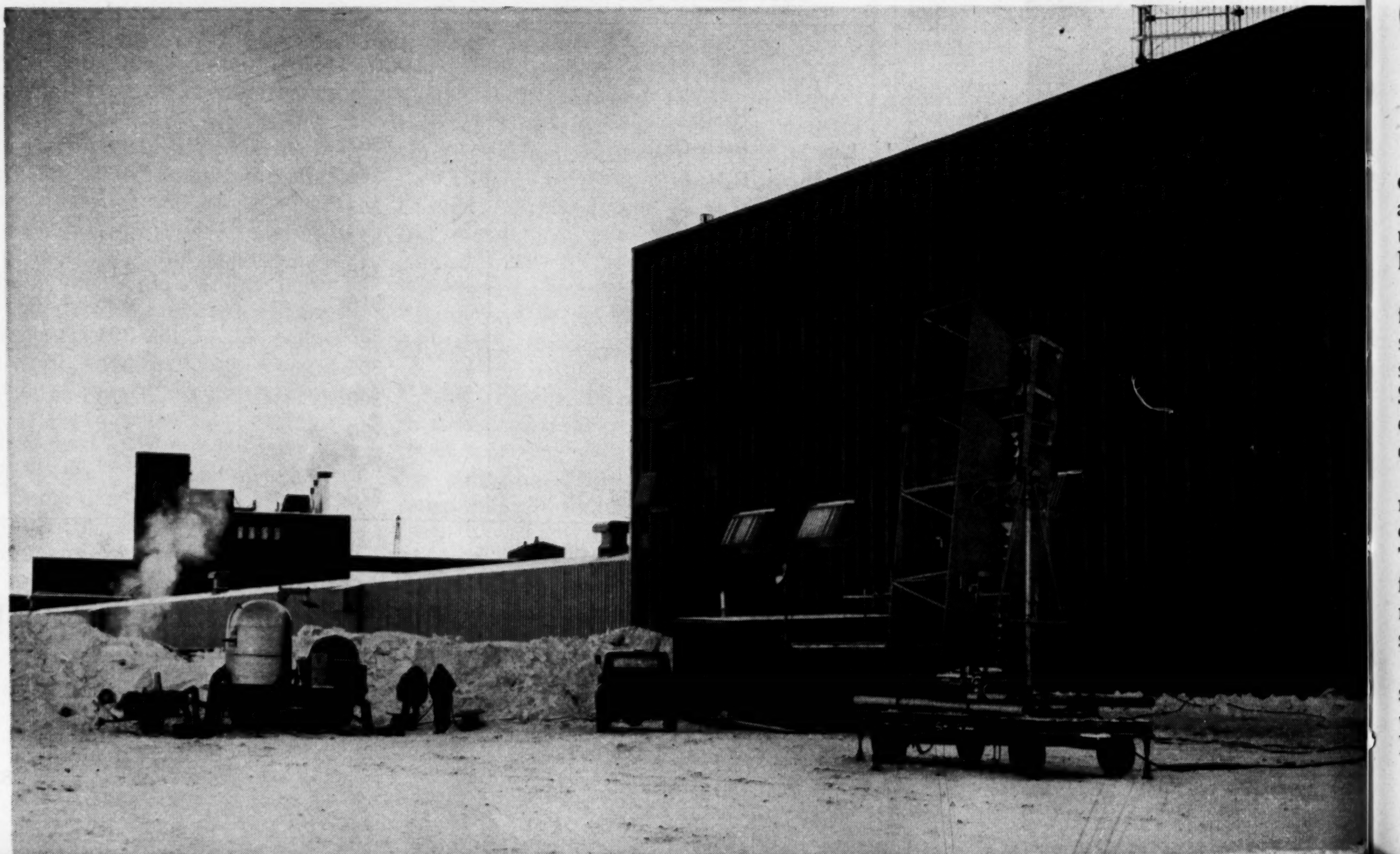
Callery Chemical Company, Defense Products Department

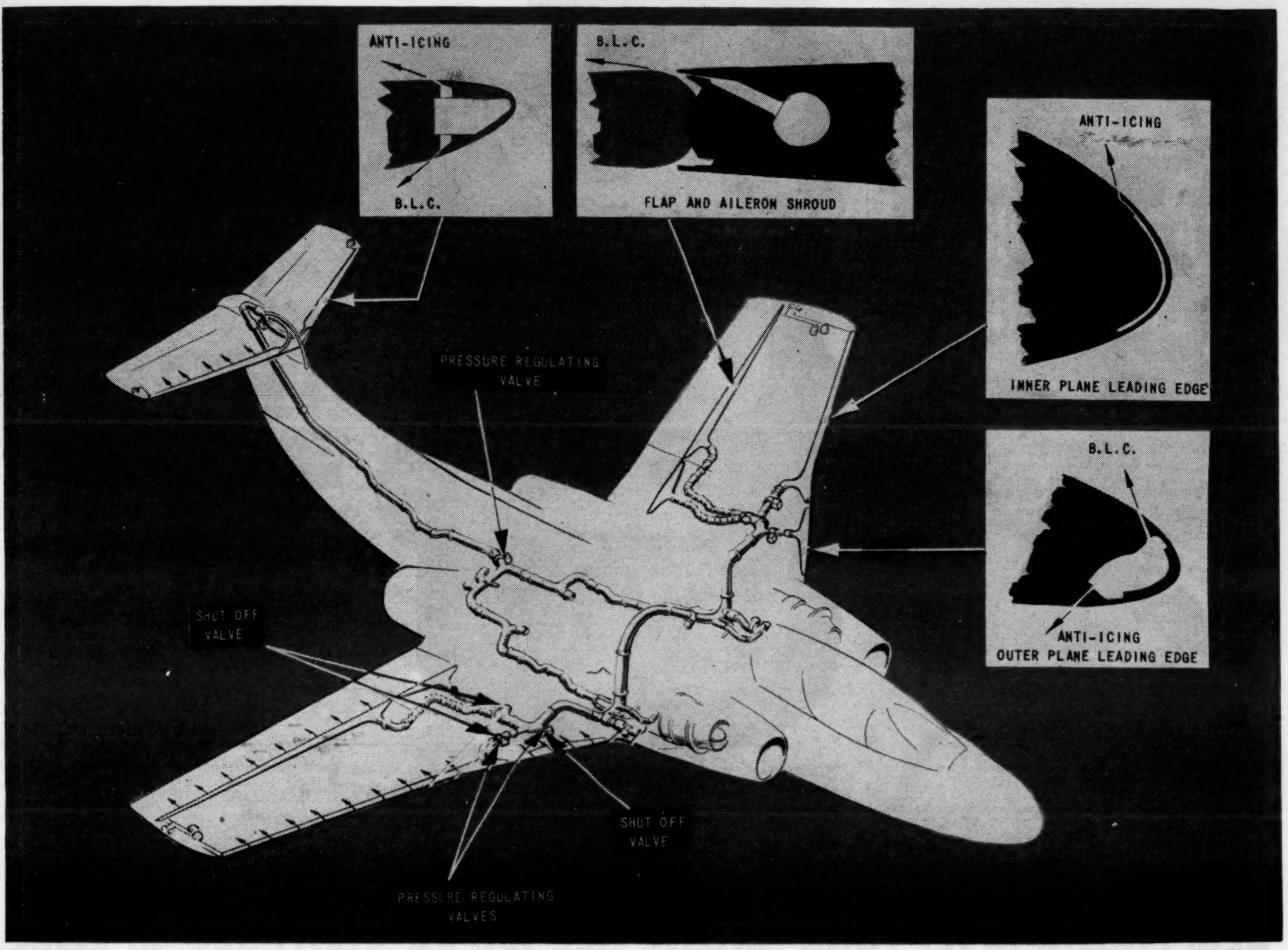
Headquarters: Callery, Pennsylvania. Telephone Evans City (Pa.) 3510
West Coast: 15537 Lanark Street, Van Nuys, California, Telephone STate 1-5761
Washington, D.C.: 709 DuPont Circle Building, Telephone ADams 4-4200
Dayton, Ohio, Suite 12, 2600 Far Hills Avenue, Telephone AXminster 8-1242



Second BMEWS Site Soon to Be Operating

Second USAF Ballistic Missile Early Warning System site at Clear, Alaska (above) will be operational late this summer to join with the site at Thule, Greenland, operational since October, 1960, in providing radar coverage of the northern polar regions. A third site is nearing completion at Flyingdales Moor in Yorkshire, England. Developed, produced and installed by General Electric's Heavy Military Electronics Department, components include three steel antenna reflectors 165 ft. x 400 ft. weighing 900 tons; 220 cabinets of electronic equipment (left) and 1,500-ft. long tunnels connecting the scanner buildings (below). The joint surveillance provided by the Thule and Clear installations will cover an area of about 3,000 mi., protecting the northern polar routes that would be traveled by the bulk of any attacking ICBM force.





GENERAL arrangement of an integrated anti-icing and boundary layer control system is shown as conceived by Blackburn Aircraft.

Combined Anti-Icing, BLC System Tested

By Herbert J. Coleman

London—High degree of efficiency is claimed by Blackburn Aircraft, Ltd., for an anti-icing system which can also be used for boundary layer control for high lift.

New system relies on heating the surface to be protected by blowing a thin sheet of hot air at sonic speeds from a slit on leading edges of primary surfaces. Slits are located between 1% and 5% of the chord back from the leading edge.

Maximum amount of bleed air needed for the system is about 5½% of the total flow through the engines. This figure compares with about 12% for the boundary-layer control system now on the Blackburn NA.39 naval strike fighter.

Technical observers speculate the new system will be installed on the Mark 2 version of the NA.39 Buccaneer (AW May 29, p. 29).

Describing the system at an anti-icing symposium sponsored here by D. Napier & Son, Ltd., Blackburn engineers A. G. Smith and C. Jones noted that the "supply pressure is such that the slit is aerodynamically choked and the air issues initially as a sonic flat jet which remains attached to the surface for a large part of the chord length."

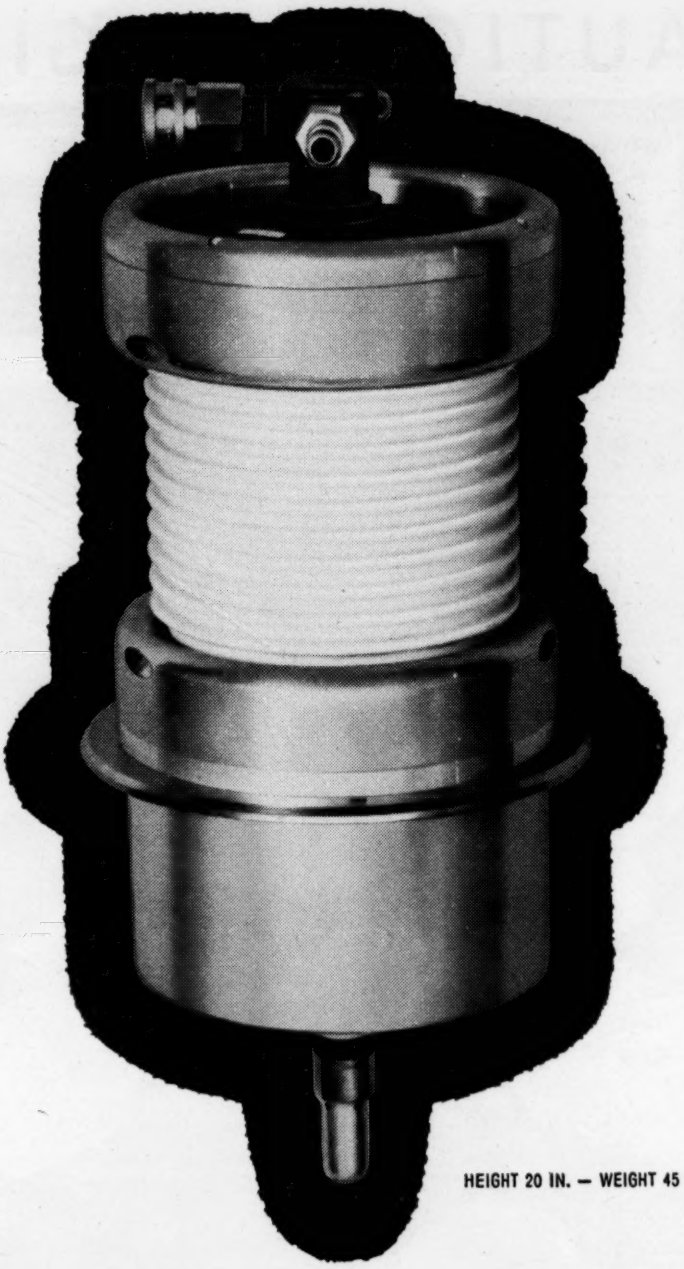
Air Source

Air is obtained from a bleed-off position on the compressor of a turbine engine and pressure should be such as to make possible a choked slit. Smith and Jones contended that this greatly eases problems of distribution of mass flow and raises the downstream distance of efficient heating, as well as boundary layer control. Pressure automatically supplies the high temperature and can be limited by ducts and valves.

Principle of blowing air for external de-icing goes back to 1946 but with subsonic flow and use of a heat exchanger. The Blackburn system depends on availability of hot compressed air in sufficient quantities.

One problem in combining the systems—anti-icing and boundary layer—has been aerodynamic requirements for thin wings with less span and sweepback. At Blackburn, boundary layer control has been accomplished by blowing air externally, through slits which are .046-in. wide, over the leading edges of full span flaps. Sheet of air issues from the slit at supersonic speeds and remains attached to the surface down to the trailing edge. On the airfoil section, further slit blowing is provided as near the leading edge as possible to postpone boundary layer separation there; leading edge slit is .025-in. wide and uses the same air supply as the trailing edge. Air from the leading edge also provides heat for anti-icing of sufficient quantity for most conditions of flight.

In addition, Blackburn has tested pos-



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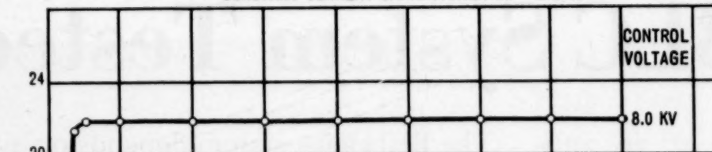
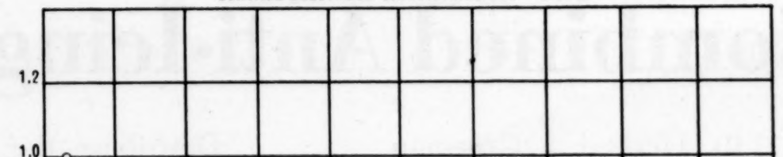


CONTROL ELECTRODE CHARACTERISTICS — L-3408



*An advanced concept by Litton for high power beam switching with high efficiency and fast rise time. Requires only low control voltages. Collector current is largely independent of collector voltage, resulting in pentode-like current characteristics. Ideal for floating deck modulators for switching modulating anode klystrons. L-3408 is in field operation now. Other models for cathode switching to 750 amps, 350 KV coming soon. *Contact us at San Carlos, California, for more information.*

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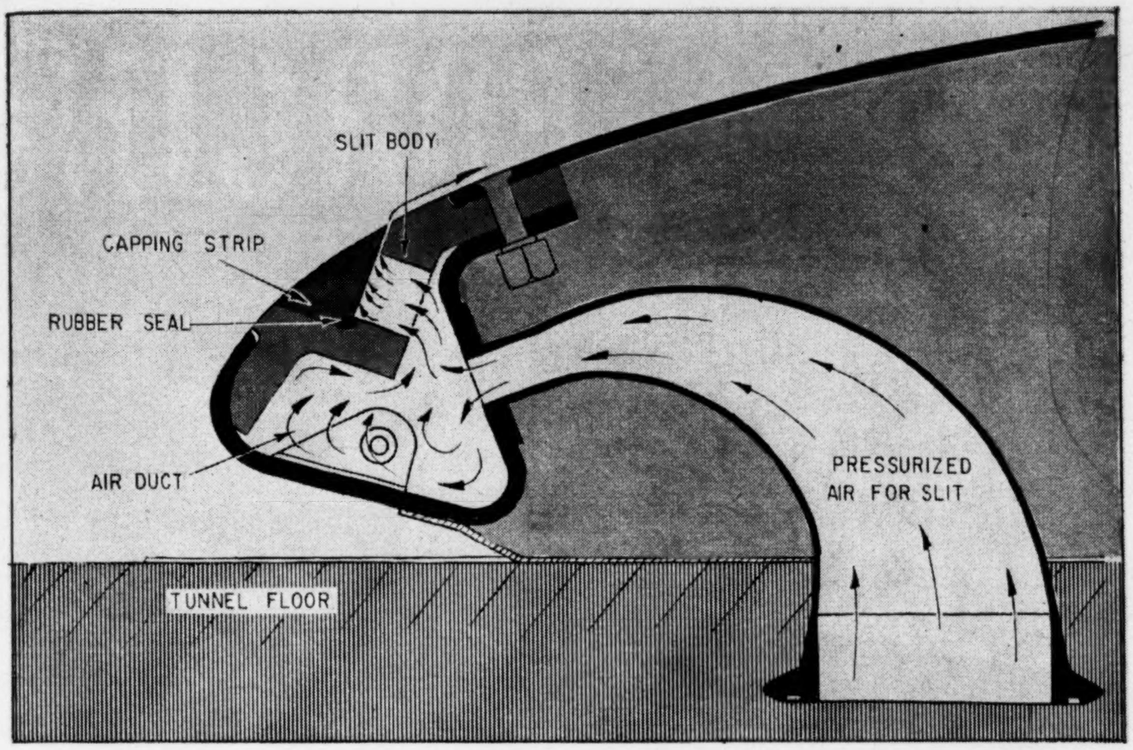

ANTI-ICING AIR is supplied to the leading edge and out through the leading edge slit.

sibilities of anti-icing the lower surface of the wing by providing still another slit, this one .005-in. wide. Similar provisions have been made on tailplane sections.

Blackburn ran tests on the system in the Napier anti-icing tunnel at Artington and on Napier's Avro Lincoln anti-icing flying testbed. One series of tests was on effect of incidence with sweepback, using half a tailplane section mounted vertically on top of the Lincoln's fuselage. Tailplane has a 0.007-in. wide blowing slit at 4% of the chord; slit could be varied spanwise by blanking strips. Planform had a 30-deg. sweepback, a 78-in. span and 62-in. mean chord.

About 15 hr. of testing was done in controlled conditions at ambient temperature of −30C and with anti-icing temperatures up to 220C and pressures up to 20 psi. Heat inputs varied from 5,000 to 20,000 Btu./hr./ft. span. Flight tests were made at 155 kt. with droplet sizes of 27 microns and 0.48 gms/m^3.

After evaluation, Blackburn concluded that "generally, the efficiency is as good if not better than the conventional hot gas systems. Ice formation was always well back of the leading edge and never in front of the slit."

Formations, according to the engineers, usually were between 7% and 11% aft of the leading edge on the upper surface and 7% and 17% on the lower surface. No ice formed for angles of incidence between −1 and +1 deg.

Blackburn claims that anti-icing at higher design speeds would be better than testbed results because of rise of surface temperature due to dynamic heating, which was not simulated on the Lincoln.

For boundary layer control, integrated with the anti-icing system, air is bled off from the end of each engine compressor through a bleed gallery around the entire perimeter of the engine casing. Air then is fed through two ducts in parallel, one of which can be closed, to a common duct between the two engines which serves as the source for all air bleed supply.

Pressure indicators fitted at the wing and tailplane tips give a ground indication that the system is functioning. In flight, the system is activated manually after ice conditions are shown by an icing detector.

Because pressures and temperatures are high for boundary layer control—on the order of 160 psia. at 225C—the pressures are reduced 25-35 psia. for anti-icing. However, temperatures remain about the same and to cope with this, ducts are made of welded Nimonic steel sheet and have operated satisfactorily. Weight penalty for the system is comparatively slight, 0.2% of the gross weight.

Important advantage, Smith and Jones pointed out, is that the system can be used during ground engine runs before takeoff to clear any ice formed on the ramp.

Smith and Jones also noted that there is a question as to whether there is a serious icing hazard when flying long distances at low level, a regime for which the NA.39 is designed, at high subsonic speeds. They said there is little evidence to work from on this aspect, but "anti-icing is available if ice forms."

In another discussion, D. C. Tanner, of T.K.S. (Aircraft De-Icing) Ltd., claimed that fluid de-icing now provides a simple and efficient means of de-icing and main interest in this method appears to lie with air cargo freighters, STOL and executive aircraft.

In the STOL field, Tanner said that

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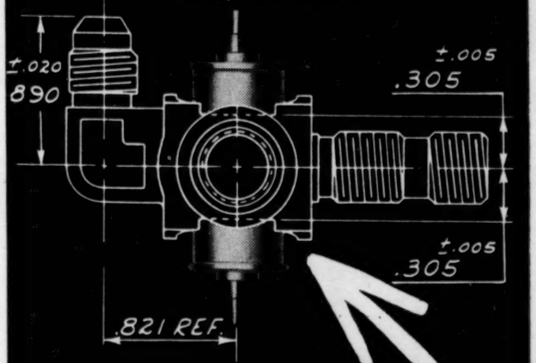

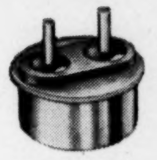

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The new Systems Command will serve as a single agency to control R&D and procurement of all aircraft, missile, avionic and space systems for the USAF from the idea stage through the time they are in the field ready for use. This concept of a single agency for both systems R&D and systems procurement will have penetrating impact on all aerospace industry companies selling hardware or research services to the Air Force.

The Systems Command will control approximately $15 billion in contracts and annually will award $7-8 billion in new contracts making it the most important single source of aerospace industry business. Further evidence of the impact on industry are policy and procedure changes which can be expected in many areas such as technical approach, contract competition, proposals, cost estimating, management structure and subcontracting.

These are just a few of the important details to be covered in the Systems Command Issue, which will constitute a new handbook in doing business with the Air Force. Teams of AVIATION WEEK editors are now visiting the various bases of the Command for full, complete reports. Detailed edi-

MILITARY SPACEPOWER"

USAF SYSTEMS COMMAND ISSUE

SEPTEMBER 25, 1961

torial coverage will be given to procurement, organization, plans and programs, policies, procedures and future technical activities.

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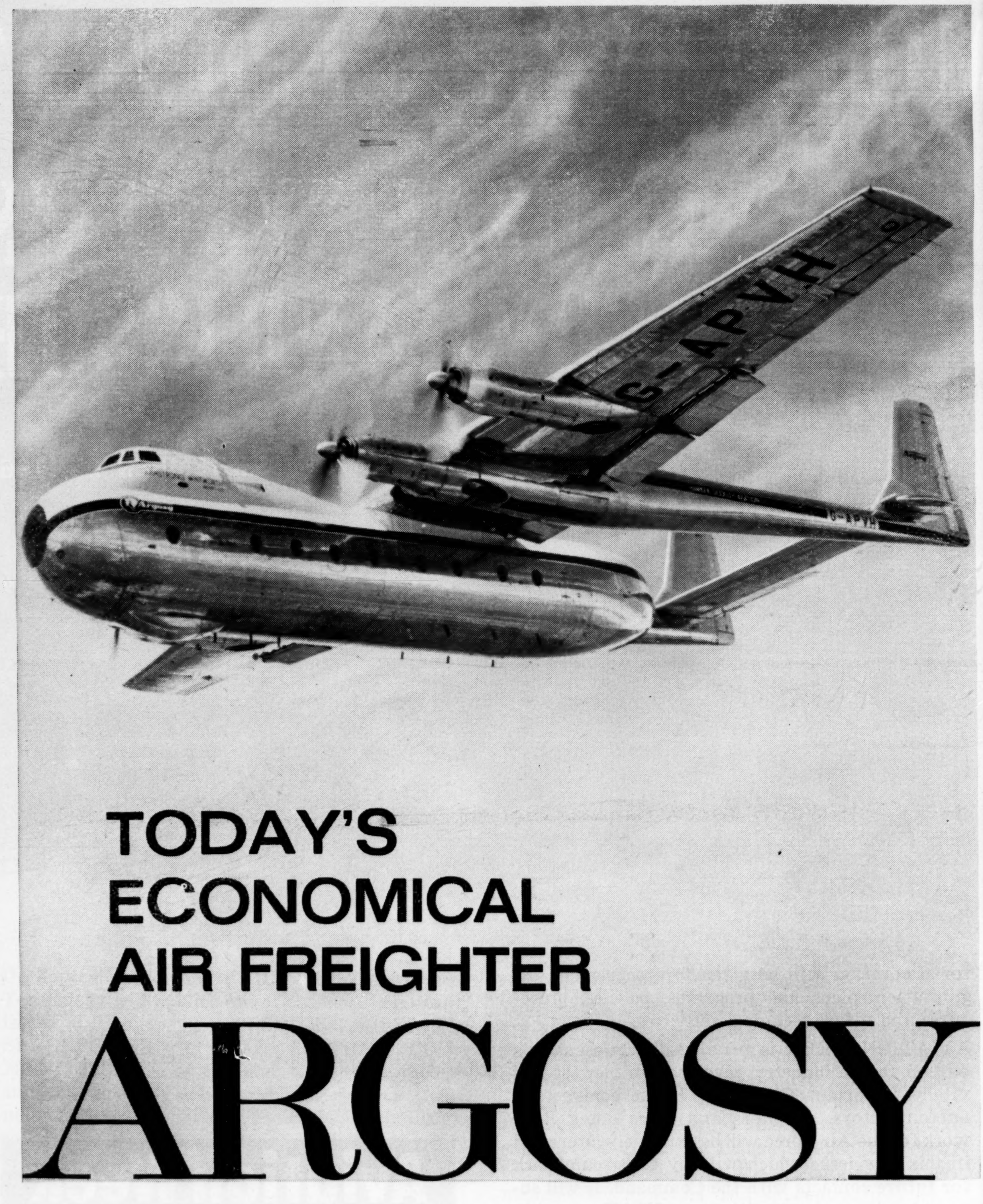

TODAY'S
ECONOMICAL
AIR FREIGHTER

ARGOSY

HAWKER SIDDELEY AVIATION 32 Duke Street, St. James's, London, S.W.1.

when movable slats are used, fluid distributors can easily be fitted, linked by a flexible hose to the fluid supply tank. Executive operators prefer the simplicity and many freighters, which use piston powerplants, cannot obtain enough hot air from this source. Company also is studying the application of liquid de-icers to higher speed aircraft and in helicopters, but Tanner stressed that there are many problems to be solved before any rotor de-icing system can be considered fully developed.

He remarked that the electric cyclic system has been more fully explored than any other, but added that he doubted it could match the fluid system for lightness. T.K.S. has had a helicopter de-icing test rig in operation since 1955, as a company-funded program, and has run considerable flight tests using a Scottish Aviation Twin Pioneer and de Havilland Dove.

Electrical de-icing of helicopter blades has been a major project of Napier's. The company recently designed and developed this system with Westland Aircraft for the Westland Wessex. Test program was conducted at Ottawa, Canada, last winter at the icing simulator facility operated by the Canadian Research Council.

R. D. Crick, of Napier, said that main rotor blade ice has only a negligible effect on the lift coefficient at normal angles of incidence and while main effect is on airfoil drag, lift can be maintained by a steady increase in power.

However, due to blade flexing, vibration and high centrifugal forces, the ice does not always stay on the blades and self-shedding keeps the helicopter airborne. But, Crick warned, self-shedding can cause damage to the tail rotor from flying chunks of ice, and also if self-shedding is not symmetric, out-of balance vibrations can be set up.

Napier's system is designed to shed ice in small enough pieces so as not to cause structural damage, and to shed it symmetrically.

For the Wessex helicopter, Napier developed heater mats, which are basically standard Spraymat heater elements, designed for chordwise shedding. On each blade there are six heater elements running spanwise from one-third rotor radius to the blade tip. Elements are joined at the tip and have a single common copper return busbar.

Tail rotor mats have a single element on each blade, covering the full span with only a small wraparound area chordwise, symmetrically placed about the leading edge.

Crick said fatigue tests with specimen mats attached to blades have shown that the mats do not detract from fatigue life of light alloy spars and that the spar fails before any sign of heat mat failure.

System has an advantage in that mats are prefabricated to be installed on the blades by the manufacturer so blades do not have to be shipped to a special factory. Main rotor mats are protected at the leading edge over the outboard section by a micro-grain nickel foil against erosion and stone damage. Tests of this foil were made at speeds up to 600 mph. by Napier and the Royal Aircraft Establishment, Farnborough.

PRODUCTION BRIEFING

General Electric Ordnance Department has a $136,000 National Aeronautics and Space Administration contract for continued development of the Project Spin cryogenic gyroscope, designed to operate at a temperature of absolute zero. Project has been funded by the Army and Navy for the past two years.

Virginia-Carolina Construction Co. will build a Scout launch vehicle assembly shop at Wallops Island, Va., under a $393,135 National Aeronautics and Space Administration contract.

Martin Orlando Division has received a $2.25-million Air Force contract to begin production of the nuclear warhead Bullpup B air-to-ground missile.

ARO, Inc., has a $25.9-million Air Force contract for management, operation and maintenance at USAF's Arnold Engineering Development Center.

Radio Corp. of America has a $496,800 cost plus fixed-fee contract to continue production of Tiros weather satellites for NASA and to provide prelaunch, launch and engineering support for Tiros operations.

Massachusetts Institute of Technology has won a $400,000 NASA contract for research, development and laboratory study of the Apollo guidance system. Eventual cost of the contract is expected to be $1.1 million.

West Germany will build ground stations enabling it to participate in National Aeronautics and Space Administration's Project Relay and Rebound communication satellite tests. NASA-German agreement is similar to earlier ones with Great Britain and France.

Remanco, Inc., Santa Monica, has developed a radar testing system, RTS-103, for checking all modes, such as air-to-air, air-to-ground, and terrain avoidance for Republic Aviation Corp., for installation in the latter's F-105 fighter-bomber.

PROBLEMATICAL RECREATIONS 76

A bunch of the chaps from Bristol dropped into a nearby pub. There were four parties: 25 physicists, 20 engineers, 18 productivity managers, and 12 comptrollers. Altogether they spent 6 pounds sterling, 13 shillings.* It was found that 5 physicists spent as much as 4 engineers; that 12 engineers spent as much as 9 productivity managers; and that 6 productivity managers spent as much as 8 comptrollers. How much did each of the four parties spend?

—Contributed

Recent tests, capped by a successful rocket sled run, have proven the capability of the Litton inertial navigation system to function in missile environments. The 30-pound P-200 stable platform, heart of the system, retained its alignment during the test. Peak sustained acceleration was in excess of 10 g's. If you're in the missile guidance market, look into Litton Systems.

ANSWER TO LAST WEEK'S PROBLEM: The time must have been 43 7/11 min. past two a.m.

****Current rate of exchange: 1 Pound Sterling ≡ 20 Shillings ≡ $2.80.***

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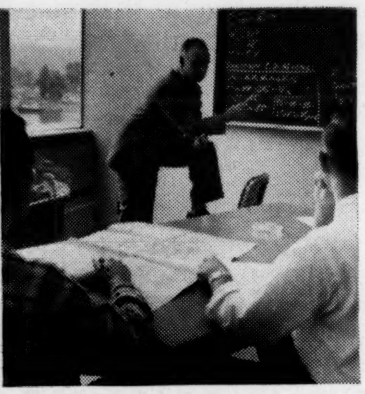

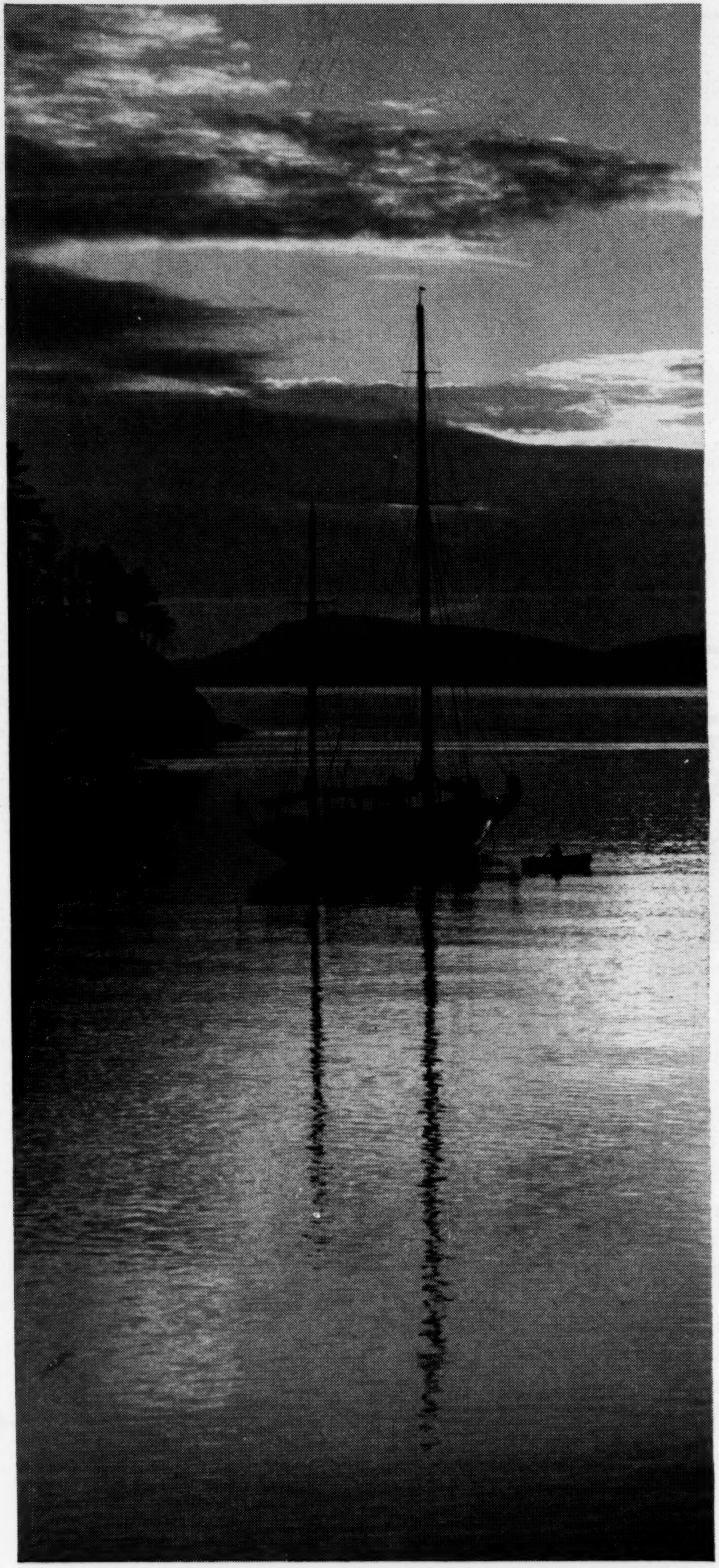

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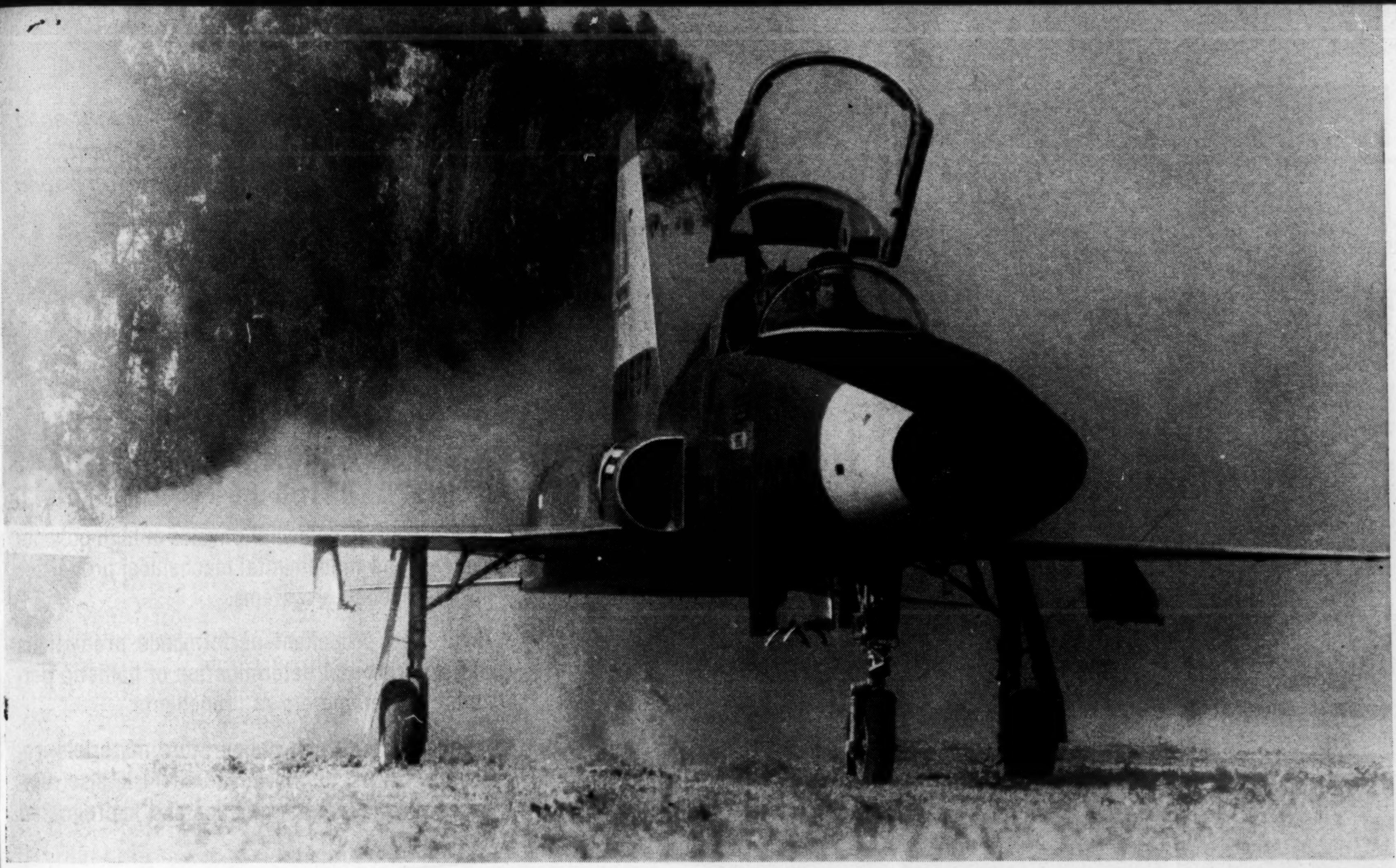
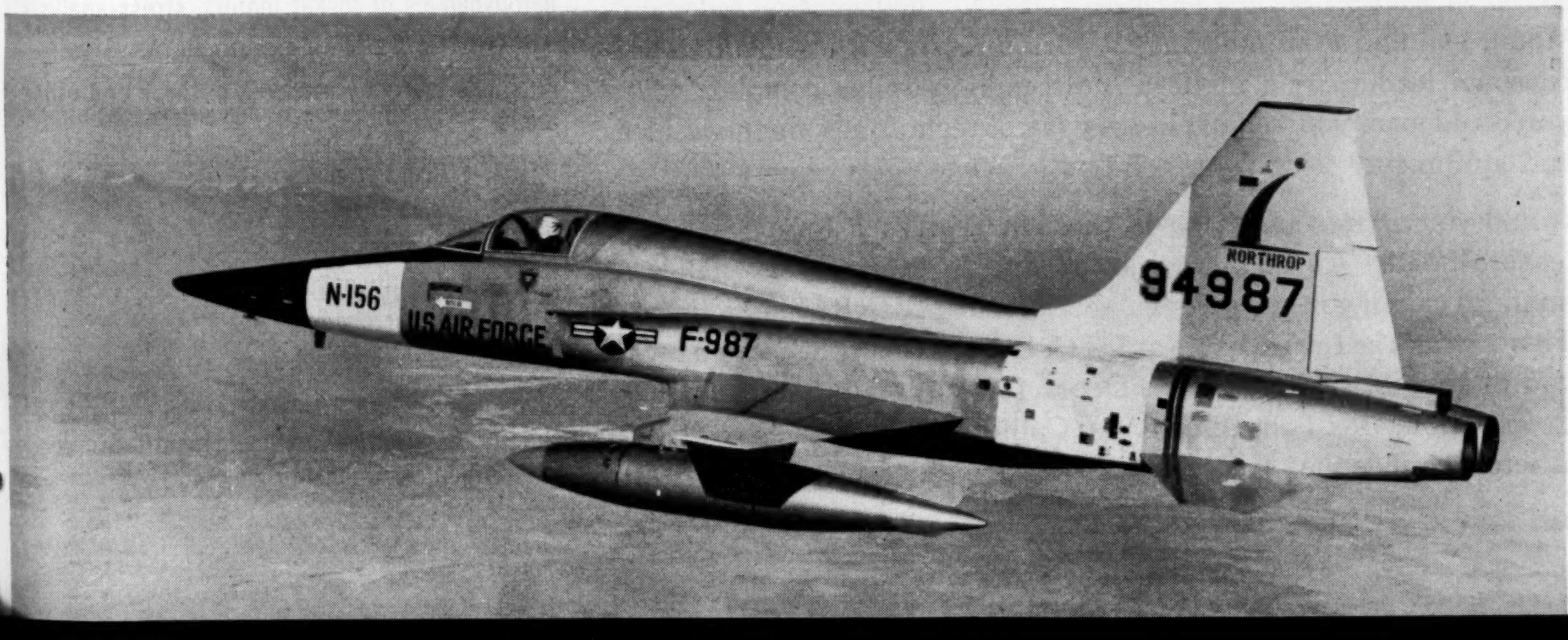


Northrop N-156, equipped with oversize, under-inflated tires, is run up for takeoff from semi-prepared sod runway at Culver City, Calif.

Northrop N-156 Operates From Hard Sod Runway

Sod runway tests are performed with the N-156 to prepare for evaluation under similar conditions next month by Army and USAF officials in interim tactical fighter competition. Tires, inflated to 115 psi., made an imprint which varied between 0.2 in. and 0.5 in. Takeoff roll was 2,400 ft. at 12,000 lb. gross weight. Slight modification of the landing gear forks was required to accommodate the 22 x 7.7 in. tires originally designed for the Convair B-58. Test airplane was equipped with non-production engines. Standard engines, Northrop officials said, should shorten takeoff roll. Hard surface runway takeoff roll was increased about 5% by the tires.



Left: Test-firing of large, flight-weight solid propellant rockets at UTC Development Center is important phase of multi-million pound thrust booster development program.

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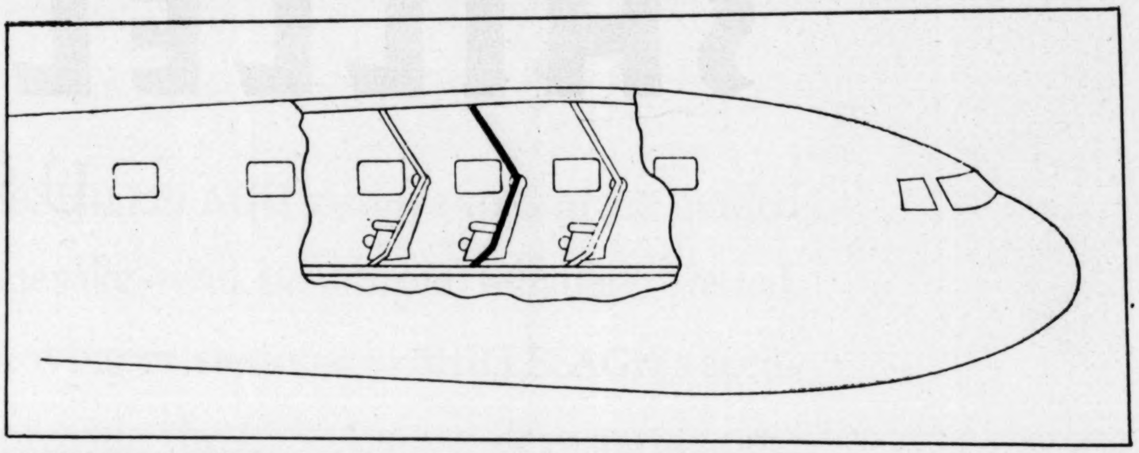
Tri-Axial Airline Seat Limits Acceleration

By David H. Hoffman



SUSPENSION SYSTEM would limit acceleration, spread g forces over passenger's entire body.

Washington—New airline transport seat that responds like a shock absorber to ground impacts has been designed to protect passengers from injury or death in survivable accidents.

Conceived by Profs. H. R. Lissner and L. M. Patrick of Wayne State University in Detroit, the "tri-axial acceleration seat" uses controlled movement to dampen the peak g forces imposed on a passenger during sudden stops. The rearward facing seat, contoured to furnish protection on three sides, also would distribute impact g forces over a passenger's entire body, sparing skeletal joints and vital organs from unendurable pressures.

Basic premise for the seat's design is that the average acceleration load generated by a "typical" airline accident—airspeed less than 150 mph., impact angle less than 30 deg.—is well within maximum human tolerances.

A "shockingly small" number of passengers survive these accidents, Lissner and Patrick report, "because their seats pull loose, they are struck by flying objects, their heads strike adjacent structures or they are crushed."

Most of these hazards stem from the fact that aircraft deceleration during a crash landing is not constant. Thus the passenger is exposed to g forces ranging well above and well below his tolerance as the aircraft skids to a halt. The "averaging" of these forces—whether vertical, longitudinal, lateral or any combination—is the seat's prime purpose.

Manufacturers' Interest

Neither Wayne State University nor the two professors intend to finance the Federal Aviation Agency technical standards test program required of most major airline accessories. However, inquiries have been received from several airline seat manufacturers, and they may do the testing with their funds if they like the design. According to Prof. Patrick, the seat could be incorporated in new aircraft at "very little extra cost."

Analyzing deceleration experiments conducted by the National Aeronautics and Space Administration, Air Force Col. John Stapp, an authority on deceleration effects, and their own work with the vertical accelerator at Wayne State, Lissner and Patrick concluded that their seat should withstand 40g for 30 milliseconds in the vertical plane, 50g for 50 milliseconds in the longitudinal plane and 20g for 40 milliseconds in the lateral plane.

To obtain such resistance, the new seat would:

- **Automatically place reclining** passengers in a more upright position to boost their acceleration tolerance. Seat travel in this instance would be in the direction of aircraft motion, thus reducing the g forces imposed on a passenger.
- **Move with respect** to the fuselage so as to absorb peak accelerations. Actual absorption of energy through controlled movement would eliminate "snap back" at the end of travel.
- **Consist of a metal shell** foundation suspended from the cabin ceiling and attached to the cabin floor. Designed for "controlled deformation" under load, the metal shell of the seat would begin to yield at the threshold of its own acceleration tolerance and continue to yield throughout the time this tolerance was exceeded.

Tri-Axial Seat Specifications

Seat Axis	Maximum Passenger Acceleration	Peak Acceleration to Be Resisted	Peak Acceleration Time Limit	Seat Travel to Absorb Peak Acceleration
Vertical	20g	40g	30 milliseconds	4 in.
Longitudinal	30g	50g	50 milliseconds	12 in.
Lateral	10g	20g	40 milliseconds	3 in.

When force is applied to the seat, energy absorbers in the seat suspension —simple extrusion or crushing devices— would hold acceleration within permissible limits. Vertical acceleration force would be counteracted by the seat's ceiling suspension, while longitudinal acceleration force would be absorbed by both ceiling suspension and floor attachments.

Mechanical repositioning of the supports and cushions contained by the shell would place a passenger in a semireclining position for comfort. As the passenger seat slides forward at its bottom to permit the back to slope, the metal shell remains in an upright position.

Reclining Mechanism

Resultant acceleration while the seat is inclined probably would be more or less perpendicular to the longitudinal body axis. "In this direction," according to Lissner and Patrick, "the body can withstand the greatest acceleration and there is no reason to return the passenger to the vertical position. On the other hand, if the acceleration is essentially longitudinal only, then the passenger will be returned to the normal seated position by the forces which tend to move him back in the seat, and the reclining mechanism will be so designed to permit these forces to return the passenger to the upright position."

The two Wayne State professors also maintain that the use of ceiling-floor suspension will allow a decrease in seat weight if present airline standards are not raised. But if more acceleration resistance is demanded, ceiling-floor suspension will furnish it without additional weight penalties. With no allowance for "trim or other frills added

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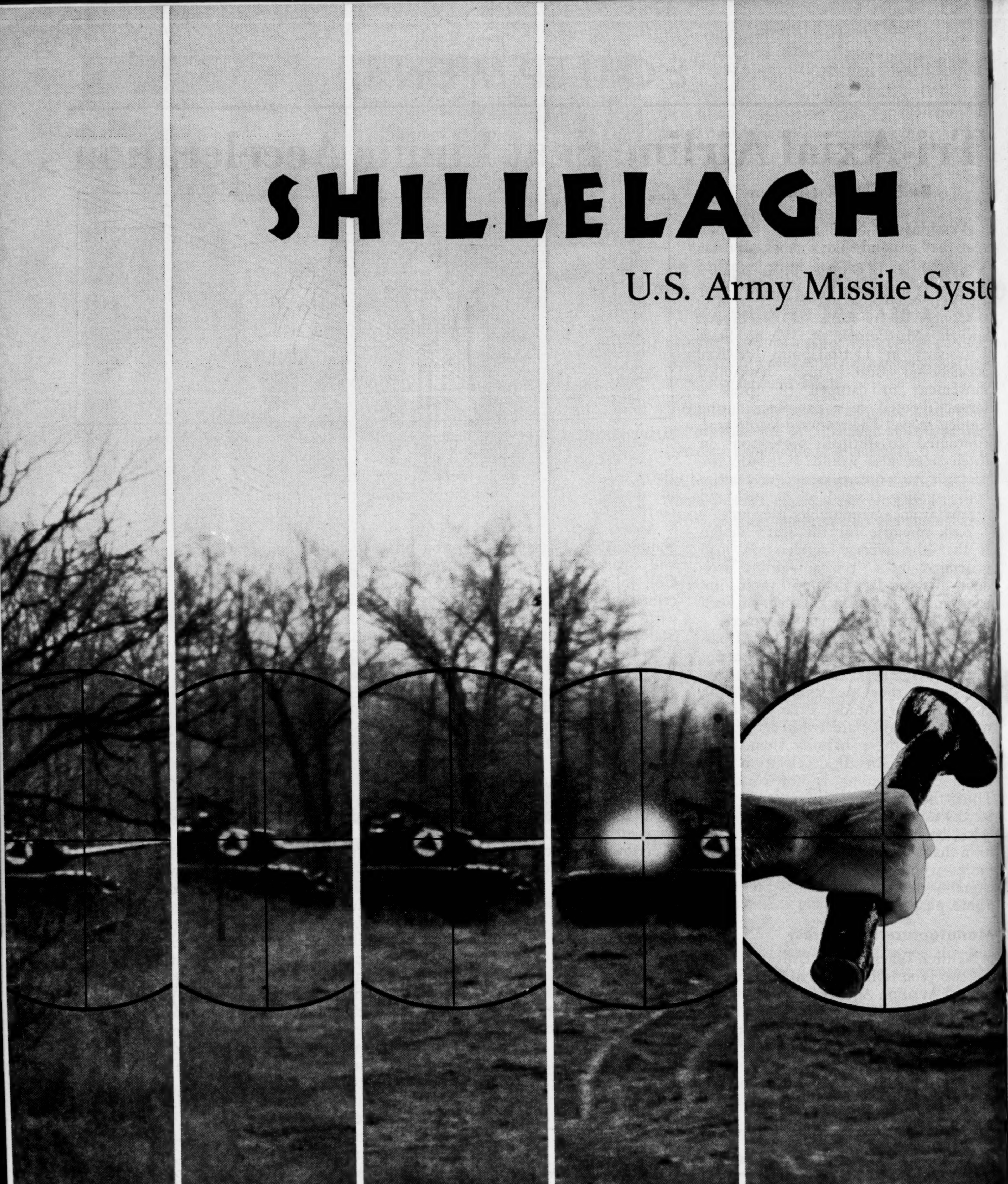

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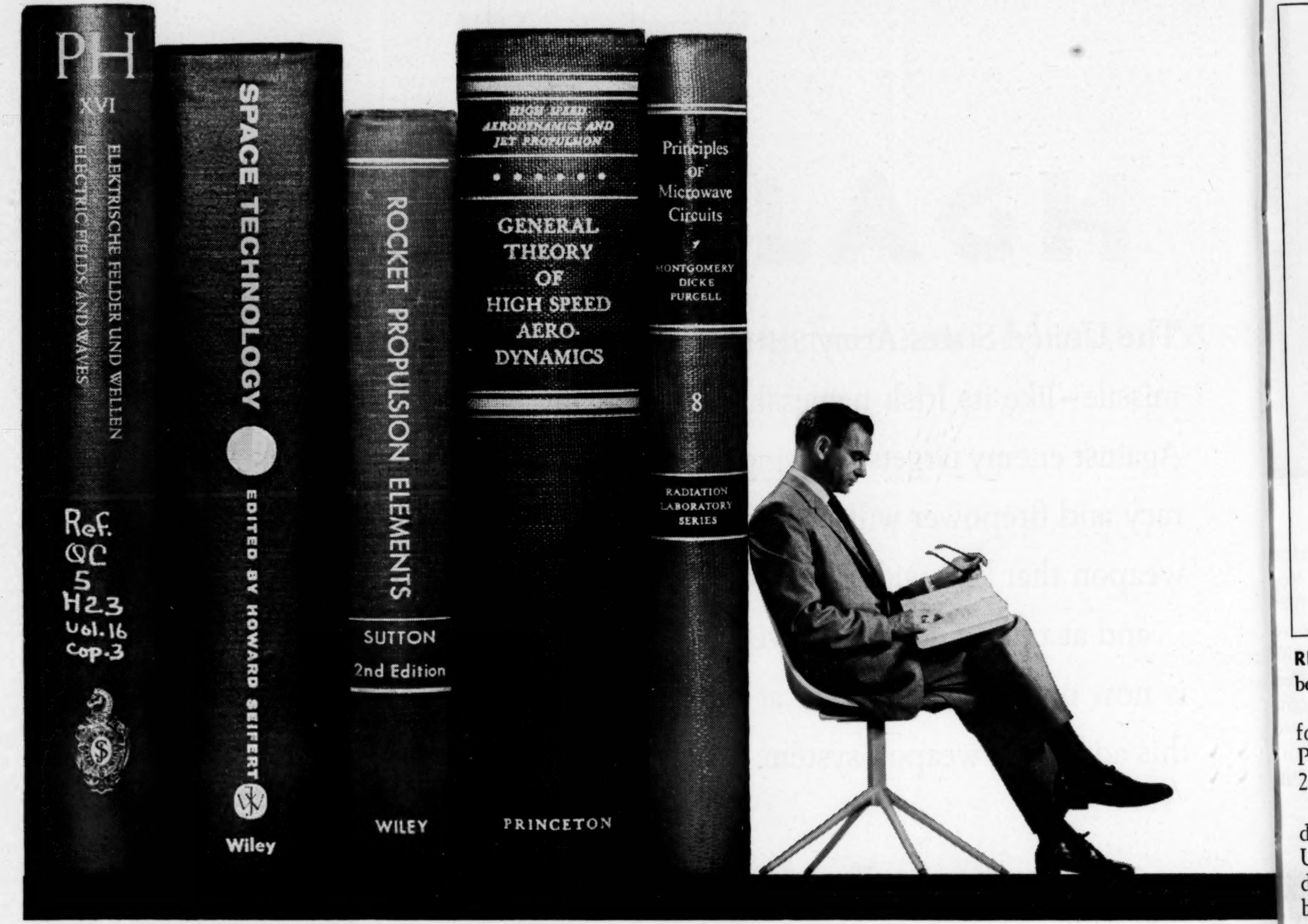
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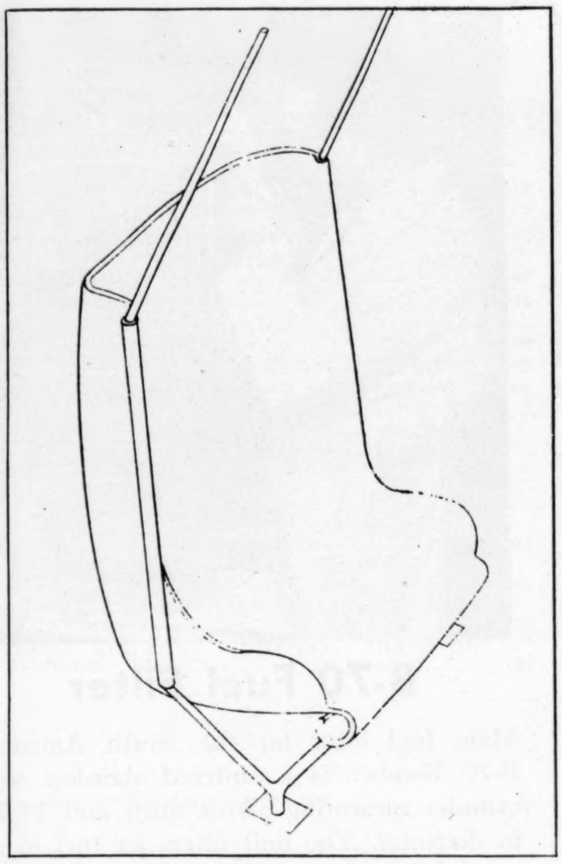

REAR-FACING tri-axial seat has top-and-bottom suspension points.

for appearance sake only," Lissner and Patrick estimate their seat to weigh 28 lb.

Preliminary details of the new seat design, which was developed under a U.S. Public Health Service grant, were disclosed here at a conference called by Federal Aviation Agency to sound out industry's views prior to rewriting the so-called crashworthiness regulations. Calling for a comparative safety analysis of forward versus rearward facing seats on airline transports, the Air Transport Assn. expressed doubt that passenger protection in survivable accidents would be increased by reversing present seating arrangements. ATA said:

"There is much evidence from crash investigations to make one wonder if reversing the seat would really provide additional over-all protections to the passenger. As a matter of fact, several qualified researchers in this field conclude that forward-facing seats actually provide the greatest all-around safety."

Shortcomings Cited

ATA then raised some of the aft-facing seat's possible shortcomings:

"Angular deceleration" might force the passenger's head from the seat support and bend it backward; the passenger's body might "skid upward" over the seat back if the seat were inclined backward more than 20 to 30 deg. at the time of ground impact; the position of an aft-facing passenger's center of gravity would impose greater stress on a seat's attachments and tend to rip it from the floor during a crash landing, and the aft-facing passenger's head would not be protected from flying objects dislodged from hat-racks and baggage shelves by the crash's impact, ATA observed.

However, Lissner and Patrick hold that their seat's contoured shell and self-erecting mechanism would minimize the chance of a passenger's being dislodged by vertical or "angular" resultant accelerations. To the contention that aft-facing seats fail at about half the g load resistable by forward-facing seats, they reply that this assumes reversal of standard airline cantilever seats.

When such standard seats are reversed, the load during a crash is applied at a higher point on the back than would be the case in a forward-facing seat. This results in leverage that causes seat failure. By supporting the seat from both top and bottom, this leverage can be minimized.

Passenger Reaction

The objection that passengers in rearward-facing seats are not protected from flying objects can be eliminated, the designers believe, by tying the potentially dangerous objects down and dividing the cabin into compartments. At the same time, infants in arms would be protected by aft-facing seats in that they would be forced toward their parents, not wrenched away from

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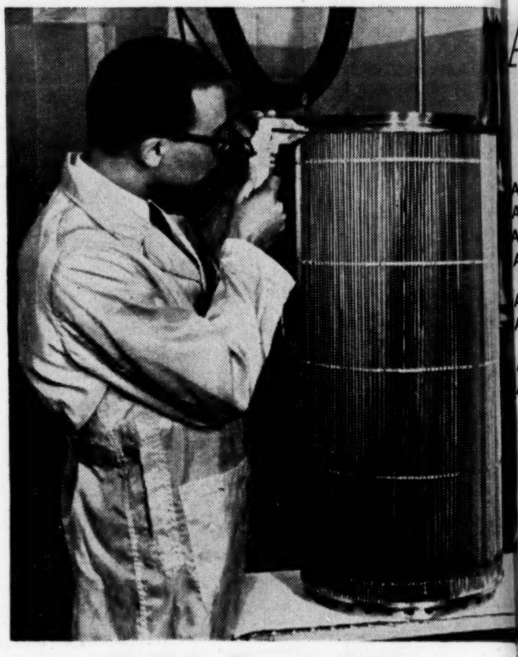

B-70 Fuel Filter

Main fuel filter for the North Americ B-70 bomber is a sintered stainless ste cylinder measuring 38 in. high and 14 i in diameter. The unit filters jet fuel to r move particles larger than 74 microns wit less than 1 psi. pressure drop. Smaller filte at each of the aircraft's six General Electri J93 engines will screen particles over 4 microns. Filter is produced by Aircraf Porous Media, Inc., a subsidiary of Pa Corp., Glen Cove, N. Y.

them, according to Lissner and Patrick.

Discounting the popular airline viewpoint that passengers would object to riding "backward," Lissner and Patrick cited an independently conducted survey of 10,000 Military Air Transport Service passengers riding in aft-facing seats which indicated that only 3% objected to the arrangement. A negative reaction to aft-facing airline seats would be a "psychological response that probably would not last after a ride of a few minutes duration," they contend.

FAA has taken no position on the aft-facing seat question. Pending further study, the agency will consider these other viewpoints expressed at the conference here:

- **Air Line Pilots Assn.,** disappointed with the quality and volume of research on transport crashworthiness since 1956, recommended that more evidence be accumulated before aft-facing seats are required by regulation. ALPA also urged that the FAA and the aircraft industry concentrate on the conditions around airports that the union believes have been responsible for the bulk of recent airline accidents.
- **Col. Stapp** favored aft-facing seats. He also urged FAA to "subsidize" safety by paying the cost of retro-fitting airline fleets with rearward seating arrangement similar to those installed on mos MATS aircraft.
- **Civil Aeronautics Board** stated tha a properly designed aft-facing sea would contribute to passenger safety However, the Board would not recommend any regulation requiring such seats at present.
- **Aerospace Industries Assn.** rejected the aft-facing seat concept until more conclusive evidence indicates the seats would enhance safety.
- **Air Force Institute of Pathology** endorsed aft-facing seats without qualification.

Automatic Landing Seen for Caravelle

Lear, Inc., and Sud Aviation of France have signed an agreement for the development of a wholly automatic landing system for the Sud Caravelle transport.

J. H. Downes, vice president and general manager of Lear's International Division said that the primary objective of the agreement was ". . . to lower present minimum weather restrictions for aircraft operations . . . and . . . provide safe, electronically controlled, fully automatic landings."

Lear's Astronics Division, Santa Monica, Calif., is conducting the program, using a B-26 type aircraft which will serve as a testbed for the Caravelle installations.

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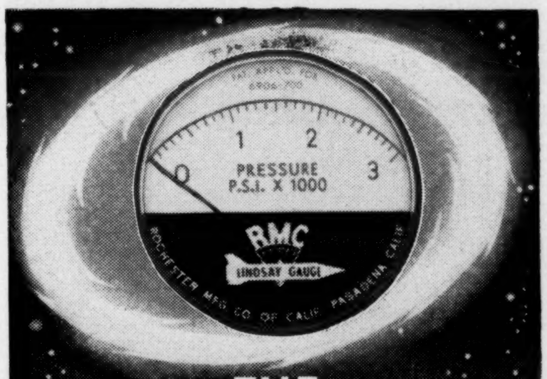

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LETTERS

U. S. Setbacks

Past experience has shown that our country has suffered many unnecessary setbacks in the field of aviation and space technology.

During World War II, our fighter planes were supposedly the finest, that is until the Japanese Zero began to shoot them down. In the Korean conflict, we were startled by the performance of the Soviet Union's MiG-15 and once again in 1957 by the Soviet Sputnik I.

We obviously have no one to blame but ourselves, or shall I say our military. Our military has the greatest research and development resources in the world to draw from, but they still sit back very complacently and ignore any new developments that may affect anything they are deeply engaged in, or should I say something in which they have a personal interest. One instance is in the helicopter field. There has been in existence since 1945, the Doman Rotor System (hingeless-tilting) far superior to anything in the military today 15 years later.

The military will not even give this rotor a fair showing, because they are apparently wrapped up in bad developments, which by the way are obvious, on which they spend millions to make work, in a futile attempt to prove themselves right in their decision.

A good example of this is the Navy's Project Vanguard. The Army was in a far better position to put a satellite in orbit than was the Navy, but millions were spent on this project anyway, only to have the Army put the first American satellite in orbit.

Anthony Mascio
Danbury, Conn.

Selecting Astronauts

I find Mr. Pike's idea (AW May 29, p. 112) very appealing, but why not carry the idea to its logical conclusion and select our astronauts from the best qualified of any nation that wants to send candidates, and extend the opportunity to civilian applicants as well as military?

K. R. Dunipace
Cocoa Beach, Fla.

Nationalistic Revival

There is a great need for a nationalistic revival in the United States. After many years I believe the general public is awakening to the fact that we did not become a strong nation with defeatist ideas. The show of guts by the man on the street will strengthen the courage of the men in Washington, and I urge each and every individual to write to his representative in Washington demanding strength in our leaders.

In keeping with this, as a businessman, our plant is erecting a flagpole. Perhaps flying the flag is old fashioned, but somewhere soon we must start in this nationalistic revival.

I shall be interested in knowing how many other businesses have a flagpole and how many other businessmen would be willing to go to the expense of installing one.

Let us become a nation of flagpoles as the first indication that we still have a national spirit and the courage to defend our ideals.

A. R. Booker
President
Everlube Corp.
North Hollywood, Calif.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Global Fighter Flight

Would you or your readers care to comment on the plausibility of a solo, nonstop flight around the world, flying time 35 to 40 hr.?

A tall order, yes; but, with midair refueling this flight could be made by one of several of our current aircraft. A twin-engine fighter would be the logical choice, but this should not exclude the F-104 or F-105 from consideration.

Why should we do it? Because it hasn't been done! This flight could well add to our national prestige. While not nearly on the level of importance as the astronaut flights, it would still demonstrate our continuing to push ahead in all of the areas of flight.

Leland D. Holcomb
Capt., USAF

P.S.—If you have the aircraft, I have the time.

Airlines Scored

As an air traveler of long standing, with, I think, a reasonable tolerance for the confusion that seems to pervade all transportation media, I am nonetheless non-plussed by a series of mixups which caused me considerable confusion and seem to point the way to a real need for better airline/customer relations.

On four flights within the past two months, utilizing the services of three different airlines, I experienced delays, food so thoroughly abominable that a package of Life-Savers had to suffice, a flight scrubbed at the last minute due to mechanical difficulties and no attendant announcement of the cancellation until 45 min. after the flight was to have departed. In most cases had I gone by rail or bus in the first place, discounting the lengthy rides out to the airport and the still lengthier rides from the airport to my final destination, I would have arrived no later than I actually did.

From the coverage given in Aviation Week to the domestic airlines' intention to visibly improve service to passengers I can only glean that either the airlines hav utterly failed to significantly improve the passenger services or I am one of thos unfortunates (perhaps because a black ca strayed across my path) who has reaped a inordinate, but not indicative amount o airline lumps.

(Name Withheld by Request

Peaceful Slogans

William K. Callam (AW July 3, p. 98 suggested a new national slogan: "Space I for Peaceful Purposes, and Aerospace Powe Is for the Preservation of the Peace."

Raymon W. Hallet, Jr., director of Douglas Aircraft Co.'s space systems research offered an interesting counterproposal at recent meeting of the Antelope Valle Section of the Institute of the Aerospac Sciences:

With all of the current proposals for th military to control space, let's give spac to the generals and admirals—and work o the peaceful uses of the earth.

James A. Marti
Lancaster, Calif.

Missing Brother

In your Mar. 13, 1961, issue on p. 175 in the upper right hand corner, appears picture entitled "Il-18 engine open for inspection."

One of the men in the picture very closel resembles my brother, whom we lost trac of during World War II.

We had some information indicatin that he was taken to Russia.

Could you please tell us where the picture was taken so that we may write to the place, and do you have a clearer or enlarged copy of the picture so that we can make a more positive identification?

I am sorry to trouble you with this, but as you will understand the matter is very dear to us.

Haim Loran
Ramat Hahayal, Israel

Pulling Together

Doesn't it seem unreasonable that with all the spectacular successes the Russians have demonstrated, including such firsts as Sputnik I, the Venus flyby and the Gagarin flight, the citizenry of this country hasn't really girded together to effectively reduce the Russian lead?

Like the Romans of old we seem to have grown so affluent and so concerned with luxuries and pleasantries that the Russians, the modern day Barbarians hovering menacingly behind the nuclear horizon, are already broadcasting our demise to the uncommitted nations of the world.

It's up to every American who wishes to forestall Khrushchev's portent that our grandchildren will be subject to communism to prepare himself for any of the sacrifices and eventualities that loom ahead of us.

(Name Withheld by Request)